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ABSTRACT

This document contains three units of a course on floor framing to be used as part of a building trades program. Each unit consists, first, of an informational lesson, with complete lesson plan for the teacher's use. Included in each lesson plan are the lesson aim; lists of teaching aids, materials, references, and prerequisites for students; techniques for learner motivation; complete step-by-step lesson presentation; applications; evaluation check list; summary; and suggested reading for students. Each unit also contains information sheets with line drawings, assignment sheets, several complete instructor's lesson plans (similar to the instructional lesson plan) for a manipulative lesson, job sheets, and task sheets. Topics covered include the following: framing lumber, installing sills and headers on foundation walls, plywood and processed wood panels, framing girders and beams on pier foundations, types of house framing and framing components, installing floor joists, types of floor frames and floor frame components, installing bridging, and installing plywood or fiberboard subfloor. (KC)

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BUILDING TRADES

BLOCK III

"FLOOR FRAMING"

DEVELOPED
BY
VOCATIONAL INSTRUCTIONAL SERVICES
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IN COOPERATION WITH
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MAJOR BLOCK III - FLOOR FRAMING

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BLOCK III - FLOOR FRAMING

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* Wagner, Willis H., Modern Carpentry, The Goodheart-Willcox Co., Inc., South Holland, IL 60473

* State Adopted Text - V.I.E. Building Construction Trades

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

III-A-1(I)

SUBJECT:	Framing Lumber
AIM:	The student will be able to identify framing lumber types, sizes, and grades. The student will further be able to calculate board feet and estimate material quantities.
TEACHING AIDS:	Information Sheet III-A-1(IS), chalkboard
MATERIALS:	Sample various sizes, grades of framing lumber to show different lumber defects
REFERENCES:	Wagner, Willis H., Modern Carpentry, Unit 4 Jones, R.P. and Ball, J.E., Framing Sheathing And Insulation, Unit 1
PREREQUISITE EXPERIENCE OF THE STUDENT:	The student must meet the prerequisites set forth by the local district and the Texas Education Agency for all vocational students. The student must further display a sincere interest in learning the building trades and skills as a career choice.

I. PREPARATION (OF THE LEARNER - MOTIVATION)

Wood is one of our nation's great natural resources. Wood, (lumber) comes from our nation's trees and forests and has long been a major building material. Even today, with all our modern building materials and methods, wood is still used extensively; especially in the framing of residential dwellings and small commerical buildings.

Framing lumber, also called dimension lumber -- it is produced in standard sizes and lengths -- is graded and marked for quality according to the number and size of flaws present. The building trades student should be able to recognize the type and grade lumber being worked, and the effects various flaws may have on the construction. The key to sound, economical construction is the proper use of the lowest grade suitable for that use.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. Wood	1. One of our great national resources 2. Comes from earth's trees and forests 3. Long been a major building material a. Relatively strong b. Easily worked c. Versatile 4. Only natural resource that is renewable
B. Classifications of Wood	1. Two major classifications 2. Softwoods (conifers) a. Cone bearing; needle-like leaves b. Evergreens 3. Hardwoods (deciduous) a. Broad leaf b. Lose leaves seasonally

C. Types of Native Wood
1. Softwoods - show examples
   a. Southern yellow pine
   b. Douglas fir
   c. Spruce
   d. Hemlock
   e. Western cedar
2. Hardwood - show examples
   a. Walnut
   b. Hickory
   c. Oak
   d. Ash
   e. Maple

D. Major Uses
1. Softwood
   a. Structural framing
   b. General construction
2. Hardwood
   a. Furniture and cabinets
   b. Paneling; flooring
   c. Speciality items

E. Structure of a Tree
1. Cells
   a. Minute, longitudinal, tubular cells
   b. Comprised of cellulose strands
   c. Held together by lignin (natural cement)
2. Cross-section of a tree
   a. Bark - protective outer cover
   b. Cambium - new growth; below bark
   c. Sapwood - recent growth
   d. Heartwood - earlier growth
   e. Pith - (center) first year growth
   f. Annual rings - indicate seasonal growth
   g. Medullary rays - cells that run cross-grain; convey nourishment to center of tree

F. Growth of a Tree
1. Growing parts
   a. Tips of roots
   b. Cambium layer
   c. Leaves
2. Growth
   a. Roots absorb water, chemicals
   b. Cells carry moisture to leaves
   c. Leaves synthesize carbohydrates (food)
   d. Process called photosynthesis
   e. Carbohydrates (nutrients) carried back to various parts of tree for growth

G. Lumber Industry Chain
1. Forestry Service
   a. Conservation
   b. Management

2. Logging industry
   a. Harvest trees
   b. Deliver logs
3. Processing
   a. Lumber
   b. Plywood, pressboard
   c. Pulp, paper
   d. By-products
4. Marketing
   a. Wholesale
   b. Retail
5. Building and construction

d. Lumber Cutting Methods

1. Two major methods
   a. Quarter sawed
   b. Plain sawed - also called flat, or slab sawed
   c. Variations of major methods
2. Plain sawed
   a. Cuts are made parallel to side of log
   b. Cuts growth rings at angles less than 45°
   c. More apt to warp; show defects
   d. Less expensive; more pieces per log
3. Quarter sawed
   a. Cuts more near perpendicular to grain of wood
   b. Lumber more stable less apt to warp

I. Seasoning Lumber

1. Is the process of reducing moisture content of green cut lumber
2. Moisture content (M.C.) - expressed as a percent of oven dried weight of wood
   a. Green lumber - approximately 50% M.C.
   b. Framing lumber - approximately 15% M.C.
3. Two major methods
   a. Air-drying
   b. Kiln-drying
4. Air-drying
   a. Lumber stacked with stickers (spacers) to allow air to vent through
   b. Placed in open air sheds
5. Kiln-drying
   a. Lumber also stacked with stickers to allow air to vent through
   b. Placed in huge ovens where temperature and humidity are controlled

J. Framing Lumber

1. Also called dimension lumber
2. Primarily produced from:
   a. Southern yellow pine
   b. Douglas fir
   c. Spruce
   d. Hemlock

3. Used in framing construction because it's:
   a. Relatively strong
   b. Straight grained
   c. Light weight
   d. Easily worked
   e. Abundant

K. Standard Sizes

1. Nominal
   a. Thicknesses - 1" thru 4" (1" intervals)
   b. Widths - 2" thru 12" (2" intervals)
   c. Lengths - 6' thru 20' (2' intervals)
2. Finished
   a. Sizes are scant due to seasoning, surfacing
   b. Varies with size of lumber

Note: See Information Sheet III-A-1(IS)

L. Framing Lumber Grades

1. Established by National Bureau of Standards, of the Department of Commerce
2. Divides softwood lumber into two groups for grading purposes
   a. Dry lumber (M.C. 19% or less)
   b. Green lumber (M.C. in excess of 19%)
3. Based primarily on strength
   a. According to the number of defects present
   b. According to the size of the defects present
4. Of the most concern to carpenters are:
   a. Select grades - B and better, C, D
   b. Common grades - #1, #2, #3, #4

M. Common Lumber Defects

1. Check, shake or split - lengthwise grain separations
   a. Check - occurs thru growth rings as a result of seasoning
   b. Shake - occurs between growth rings
   c. Split - extends from one surface thru to opposite surface
2. Pitch or pitch pocket - an accumulation of resin in cells; between growth rings
3. Decay - disintegration of wood due to wood destroying fungi
4. Knot - limb portion of tree embedded in trunk when cut and processed into lumber
   a. Knots classified according to size, quality and occurrence
   b. Graded on percentage of area that will produce clear cuttings
5. Torn grain - part of wood torn out in dressing
6. Wane - bark or the lack of wood from any cause on the edge or corner of lumber

7. Warp - any variation from a true or plane surface
   a. Bow - deviation flatwise from end to end
   b. Crook - deviation edgewise from end to end
   c. Cup - deviation flatwise across the width

N. Lumber Calculations

1. Are made in board feet
2. Board foot
   a. Define - the unit of measure for lumber
   b. Describe - piece 1" thick x 12" wide x 12" long

Note: Use nominal dimensions

3. Formula for figuring board feet

$$\frac{\text{No. Pcs. x thickness" x width" x length'}}{12} = \text{Bd.Ft.}$$

Example: $20 \times \frac{2" \times 6" \times 16'}{12'_1} = 320$ Bd.Ft.

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS, OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

Instructor: Display number samples of various sizes, types framing lumber
Students: Identify lumber size, type wood of each sample

Instructor: Display numbered samples of framing lumber with various defects
Students: Identify defects by name, each number. Describe defect!

Instructor: Passout Assignment Sheet III-A-1(AS)
Students: Complete assignment as per instructions, return to instructor for grade
Students: Make list of wood products, by-products

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENT'S COMPREHENSION OF MATERIALS PRESENTED.)

Simple Recall:

1. Wood is our only natural resource that is _____. renewable
2. Wood is an excellent building material because it is relatively strong, easily worked and ____. versatile
3. The two major classifications of wood are conifers and _____. deciduous
4. Conifers means ____. cone-bearing

5. In the structure of a tree, wood cells are composed of _____.	cellulose
6. The natural cementum that holds wood cells together is called _____.	lignin
7. Leaves synthesize carbohydrates for nutrition and tree growth through a process called _____.	photosynthesis
8. Moisture content of green cut lumber is approximately _____%.	50
9. The process of reducing moisture content of green lumber is referred to as _____.	seasoning
10. The controlled drying of lumber in large ovens is called _____ drying.	kiln
11. Another name for framing lumber is _____ lumber.	dimension
12. Standard lengths of framing lumber are 6' through 20' in _____ intervals.	2'
13. The finished width of a 2" x 4" is actually _____.	3½"
14. The unit of measure for lumber is the _____.	board foot
15. Lumber is graded according to the number and size of _____ present.	defects
16. The appearance of bark along the edge of dressed lumber is referred to as _____.	wane
17. Lumber which varies from a true or plane surface is said to be _____.	warped
18. The accumulation of resin between growth rings in lumber is a defect known as a/an ____ pocket.	pitch
19. A board foot is a piece 1" thick x 12" wide x ____ long.	1'
20. Size dimensions used in calculating board feet refer to _____ sizes.	nominal

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

Wood is one of our great national resources. It is the only resource that is renewable, and has long been a major building material.

There are two major types of wood according to tree classifications. Hardwoods are produced from deciduous trees; trees of a broad leaf which are lost seasonally. Softwoods are produced from conifers; cone-bearing trees with needle-like leaves. Evergreens!

Framing lumber is produced from softwoods because it is relatively strong, straight grained, light weight, easily worked, and abundant. Examples of native softwoods are Doublas fir, spruce, hemlock, and southern pine.

Framing lumber, also called dimension lumber, is milled to standard nominal dimensions: 1" to 4" thickness in 1" intervals; 2" to 12" widths in 2" intervals; 6' to 20' lengths in 2' intervals. Actual thickness and width dimensions of finished lumber are scant due to surfacing and seasoning.

Framing lumber is graded primarily on strength according to the number and size of defects present. Types of defects considered are checks, splits, knots, decay, wane, and warp.

The grades most associated with carpentry and construction are selects and commons. Select grades carry letter designations B and better, C, D. Common grades carry number designations 1, 2, 3, and 4. Minimum requirements of each grade are formulated by the National Bureau of Standards, U.S. Department of Commerce.

Quality construction does not require that all lumber be of the best grade. The key to good, economical construction is the selection of the lowest grade suitable for the purpose.

Framing lumber is purchased by specifying quantity, size, grade, and type wood. Quantity is calculated in board feet. A board foot is described as a piece of wood 1" thick x 1" wide x 1' long(nominal dimensions) or its equivalent. To calculate board feet use the formula:

$$\frac{\text{No. Pcx.} \times T \times W \times L}{12} = \text{Bd. Ft.}$$

SUGGESTED READING FOR STUDENTS:

Modern Carpentry, Chapter 4

THE NEXT LESSON IS: III-A-2(I), Plywood and Processed Wood Panels

SUBJECT: Framing Lumber

INTRODUCTORY
INFORMATION:

Wood comes from the earth's trees and forests and is one of our nation's great natural resources. Wood has played an important role in the development of this country and has given rise to many of its large industries. Wood and/or wood products touch practically every citizen, every day of their life. Just look around you! Make a quick survey of items produced from wood. This will give you some indication of its many uses and applications.

Wood has long been used as a major building material. It is relatively strong, light weight, easily worked and durable. Cut into pieces of standard thicknesses, widths, and lengths it becomes lumber. Rotary peeled into thin sheets, cross-laminated to various thicknesses and trimmed to standard sized sheets, it becomes plywood. Both are used extensively in the construction of residential dwellings and small commercial buildings.

As a carpenter, the student of building trades works constantly with lumber and wood products. He/she must have a good working knowledge of lumber and wood products -- kinds, grades, sizes and other aspects that apply to its selection and use.

GENERAL INFORMATION:

Structure And Growth Of Wood

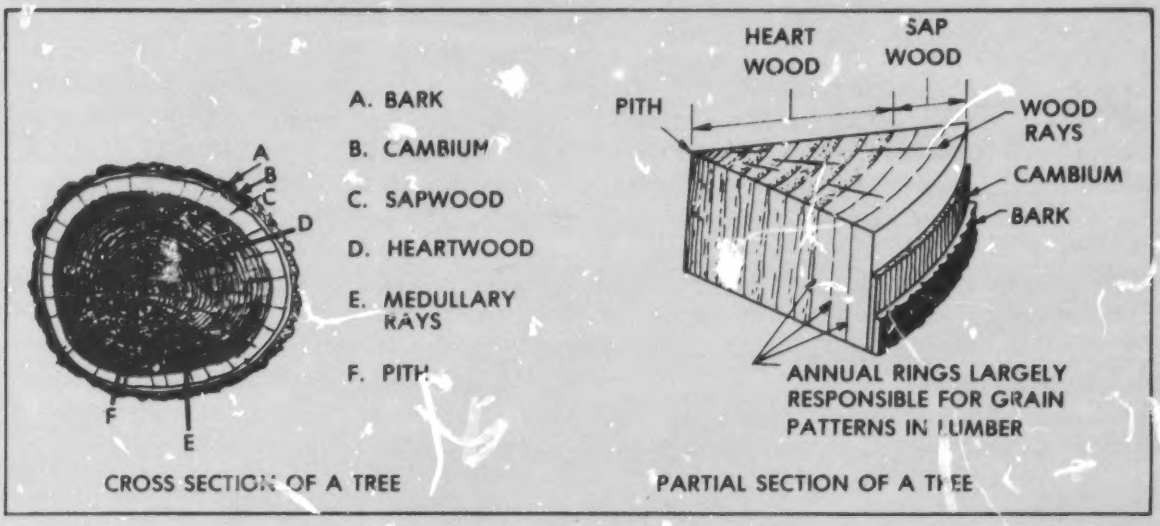
There are as many types of woods as there are trees. However, their structure and growth are all similar. Wood is composed of millions of longitudinal hair-like cells approximately 1/8" long through which moisture and nutrients are carried to feed the tree. These cells are composed of tiny strands of cellulose and are held together by a natural cementum called lignin. This cellular structure is what makes it possible to drive nails and screws into wood and accounts for its lightweight, insulating, and sound absorbing qualities.

Trees grow when water absorbed by the roots, travels up through the cells of the sapwood to the leaves. There, through a process called photosynthesis, it is combined with carbon dioxide from the air to form certain carbohydrates (food for growth) which is then carried to various parts of the tree.

Annual growth occurs in the spring and summer months when a tree's leaves are

green and in full foliage - the green leaves' chlorophyll, and radiant energy (sunlight), are requirements of photosynthesis.

New growth occurs laterally in the cambium layer just below the tree's bark. Rapid growth in the spring and early summer when conditions are most favorable, and slower, more dense growth in the late summer and early fall create layers called annual rings. Annual rings are largely responsible for grain patterns seen on the surfaces of lumber.



CROSS SECTION OF A TREE

PARTIAL SECTION OF A TREE

Sapwood is the recent, outer layers of growth still containing living cells. It may be several inches thick. As the tree ages, the cells of the inner layers become inactive and turn darker due to the presence of resins and tars. It is then referred to as heartwood. The center or first year's growth is called the pith. Heartwood is generally the preferred cut in lumber - not that it is any stronger than sapwood, but it is more durable when exposed to weather.

Types Of Wood

The two major types of wood are grouped according to the two major classifications of trees. Softwood comes from "conifers"; cone-bearing trees with needle-like leaves; often called evergreens. Hardwood is produced from deciduous trees; broad-leaf trees which shed their leaves seasonally.

PINE CONIFER SOFTWOOD

OAK DECIDUOUS HARDWOOD

Native samples:

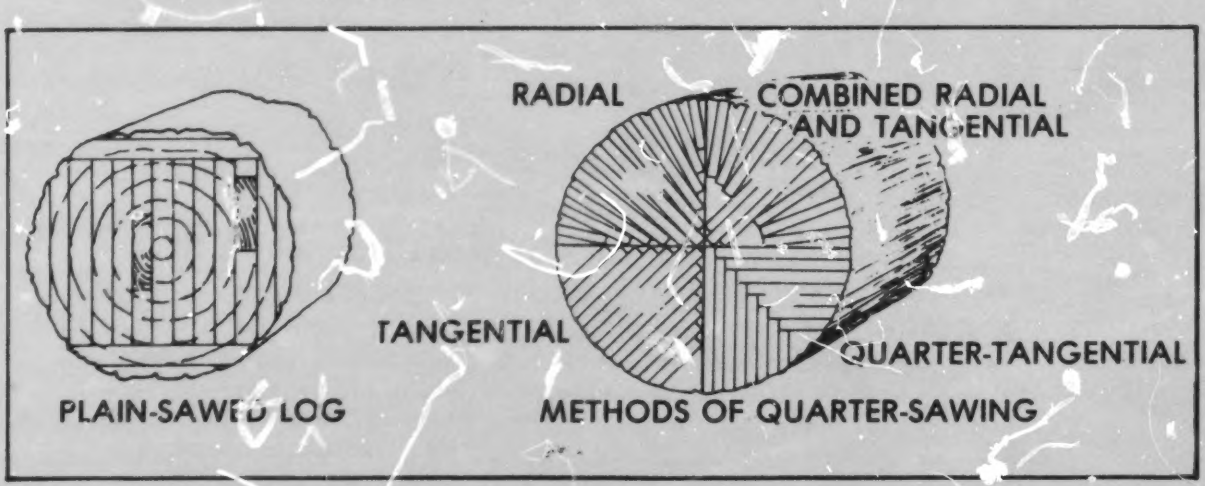
SOFTWOOD	HARDWOOD
Pine (all types)	Oak (all types)
Douglas Fir	Ash
Western Larch	Birch
Hemlock	Maple
Spruce	Hickory
Redwood	Walnut
Cypress	Pecan
Western Cedar	

Framing lumber is made primarily from four varieties of native coniferous wood: Southern yellow pine, Douglas Fir, spruce and hemlock. These woods are used for framing and construction because they are relatively strong, straight grained, light-weight, easily worked, and abundant. Southern yellow pine is found from Virginia to Texas.

Methods Of Cutting, Seasoning Lumber

The two major methods of sawing logs into lumber is plain-sawed and quarter-sawed. Most lumber today is plain-sawed; also called slab-sawed, slash sawed, and flat sawed (colloquialisms).

Plain-sawed lumber is cut parallel to the side of the log after the log has been squared, and generally cuts the annual rings at an angle less than 45 degrees exposing more of the hard grain on the lumber surfaces. This is a common method of sawing framing lumber as it is quicker and produces less waste per log.



Quarter-sawed lumber is cut to produce an angle greater than 45 degrees with the annual growth rings. This produces lumber that is more dimensionally stable and less apt to warp but requires more time, as the sawyer must turn the log with each cut, and produces more waste. This method of sawing is generally used to produce quality hardwood lumber from each log.

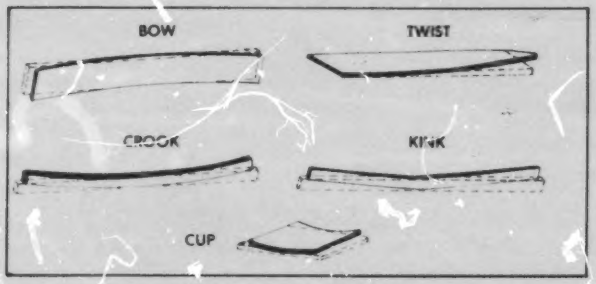
Freshly cut lumber is referred to as green lumber. It has a moisture content of about 50%. Seasoning is the process of reducing this moisture content to required levels to meet particular grade specifications and use.

There are two methods of seasoning lumber; air drying and kiln drying. Air drying is simply the stacking of lumber in open air sheds in such a way that air may circulate through the stacks. This is accomplished by using stickers (wood strips) between layers and spaces between stacks. Air drying is the slower of the two methods and will only achieve the E.M.C. (equilibrium moisture content) of the surrounding atmospheric conditions. Kiln drying places the lumber in huge ovens where the temperature and humidity are controlled. Fans are used to circulate the air over the lumber. Kiln drying is faster and produces a higher quality lumber (less warping and staining). Framing lumber is generally seasoned to an average of 19% M.C.

Basis For Grading Lumber

Framing lumber is graded primarily on the basis of strength according to the number and size of the defects present. Grading standards were devised by the National Bureau of Standards of the Department of Commerce. A defect is defined as "any irregularity occurring in or on wood that may lower some of its strength or durability values." A blemish is defined as anything marring the appearance of wood, but not classified as a defect. Defects that most affect lumber grades are:

Warp - any variation from the true or plane surface of the lumber. These include bow, crook, twist, kink, and cup.

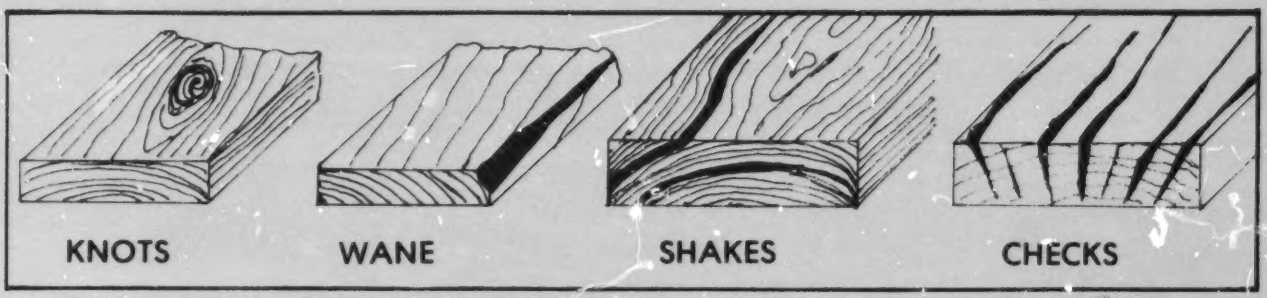


Knots - are caused by limbs imbedded in the tree's trunk. When the tree is cut into lumber, knots are considered strength reducing. The lumber is graded according to the size of the knot - percent of the cross-sectional area of the lumber it occupies, and its tightness in the wood.

Wane - is the presence of bark or the absence of wood; usually along the edge of lumber, which reduces the cross-sectional area, therefore reducing the strength of lumber.

Shakes - are separations of the wood between annual rings running lengthwise with the board.

Checks - are cracks across the annual rings running lengthwise with the board. Checks usually occur on the ends of lumber from rapid or uneven drying.

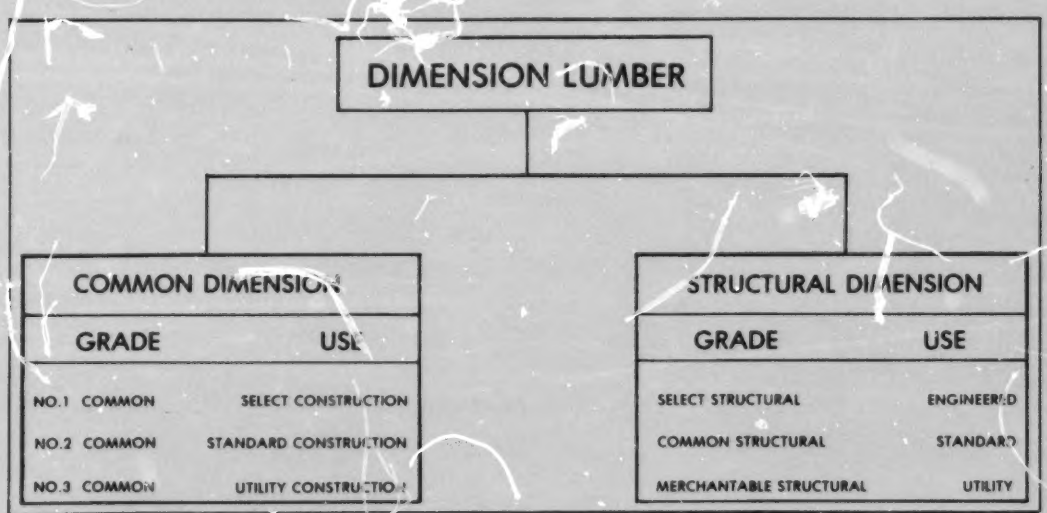


Rot - is the deterioration of wood due to the action of fungi. Visible signs of rot are wood that is soft, spongy and crumbles easily. May be wet or dry but occurs in the presence of moisture.

Framing Lumber Grades

As stated, the National Bureau of Standards of the Department of Commerce established standards for grading softwood lumber. These standards serve as guidelines for the major associations of lumber producers, each of which have their own grade rules and specifications. If you are working primarily with lumber produced by a particular association, obtain their specific grade specifications.

In general, framing lumber is divided into two groups; common dimension lumber, and structural dimension lumber. Common dimension lumber is the group most used in ordinary construction and is the one of most concern to carpenters. Common dimension lumber is milled in 2" and 4" nominal thickness with widths 2" thru 12" in 2" intervals, and lengths 6' thru 20' in 2' intervals. Grades are indicated by number - the lower number indicating the higher grade (see chart).



No. 1 dimension lumber allows small tight knots, pitch pockets, and other defects that do not impair strength.

No. 2 dimension lumber has slightly less strength than No. 1 and is used in "standard" construction framing.
No. 3 dimension lumber allows large knots, knot holes, decay, and checks and is referred to as "utility" lumber.

Wood cut to a thickness greater than 4" is referred to as timber. Boards and dimension lumber for general use are planed to the proper thickness and width after sawing. The following chart indicates actual finished thicknesses and widths of nominal size framing lumber.

Thickness		Width	
Nominal	Dressed	Nominal	Dressed
1	3/4	2	1 1/2
1 1/4	1	3	2 1/2
1 1/2	1 1/4	4	3 1/2
2	1 1/2	5	4 1/2
2 1/2	2	6	5 1/2
3	2 1/2	7	6 1/2
3 1/2	3	8	7 1/4
4	3 1/2	9	8 1/4
		10	9 1/4
		11	10 1/4
		12	11 1/4

How Lumber Is Sold

A board foot is defined as a piece of wood 1" thick x 12" wide x 12" long or its equivalent. The dimensions referred to are nominal lumber dimensions. Other examples of a board foot are a 2" x 6" x 12" long, and a 2" x 4" x 18" lg. The formula for figuring board feet is: thickness in inches x width in inches x length in feet divided by 12.
Example: A 2 x 4 stud 8' lg. would contain 5 1/3 board feet.

$$\frac{T \times W \times L}{12} = \text{Bd. Ft.} \quad \text{or} \quad \frac{2 \times 4 \times 8^{2}}{12_{3}} = \frac{16}{3} = 5\,1/3 \text{ bd. ft.}$$

Multiply this by the number of pieces the same size for quantities.
Example:

$$\frac{\text{Pcs.} \times T \times W \times L}{12} = \frac{24^{2} \times 2 \times 4 \times 8}{12_{1}} = 128 \text{ bd. ft.}$$

Lumber is sold by the board foot, 100 board feet, and 1,000 board feet.
Lumber prices are generally quoted by the 1,000 board feet.
Example: #2 common, southern yellow pine quoted @ $415.00 M (thousand).
Therefore #2 common, southern yellow pine should sell @ $41.50 C (hundred)
@ $ 4.15 per 10 bd. ft.
@ $ .415 per board foot
If the studs in the examples above cost .41¢ a board foot, the price of the (24) studs would be $53.12.

ASSIGNMENT SHEET
IN
BUILDING TRADES

III-A-1(AS)
(p. 1 of 2)
Key

SUBJECT: Lumber/Cost Calculations

AIM: To develop the student's ability to calculate board feet and arrive at a cost figure for varying quantities of lumber.

INTRODUCTORY INFORMATION: Lumber is sold by the board foot. A board foot is defined as, "a piece of wood 1" thick x 12" wide x 12" long or its equivalent." These figures refer to nominal lumber dimensions. Since lumber comes in several standard thicknesses, widths, and lengths, the board footage must be calculated. The formula for figuring board feet is: $\frac{\text{number of pieces x width in inches x length in feet.}}{12}$

After the number of board feet has been computed, it must be multiplied by the cost per board foot to arrive at the cost of quantity calculated. Since lumber is priced per thousand (M) board feet, move the decimal point three (3) digits to the left to determine the unit price per board foot and multiply by the number of board feet.

Example: #2 common Douglas fir cost $395.00 M. How much would (72) 2 x 4 x 8' studs cost of this material?

$\frac{72 \times 2 \times 4 \times 8}{12} = 384$ bd.' x .395¢ = $151.68

REFERENCE: Feirer, John L., Guide to Residential Carpentry, Bennett Publishing Company, Peoria, Illinois 61615, pp. 31-32

QUESTIONS OR PROBLEMS:

1. A 1 x 4 x 6' lg. contains ___ board feet. 2
2. A 2 x 4 x 12' lg. contains ___ board feet. 8
3. A 2 x 6 x 16' lg. contains ___ board feet. 16
4. A 2 x 8 x 16' lg. contains ___ board feet. 21 1/3
5. Three 1 x 12s x 10' lg. contain ___ board feet. 30
6. Eighteen 2 x 4 studs, 8' lg. contain ___ board feet. 96
7. A stack of lumber contains (18) 2 x 4 x 16' lg., (80) 2 x 4 x 8' lg., (16) 2 x 6 x 18' lg., (6) 1 x 4 x 16' lg. The total number of board feet in the stack is ___. 938 2/3

8. A stack of (38) 2 x 10 x 14 lg. #2 common sells @ $490. M. The stack of lumber would actually cost ____. — $434.46

9. The floor frame of a house calls for (25) 2 x 6 x 16' lg. joists. How much would it cost to purchase the joists @ $475 M. board feet. — $190.00

10. #1 common Southern yellow pine sells @ $590 M. board feet. 2,300 board feet would cost ____. — $1,357.00

11. A stack of 1 x 6 x 12' lg. lumber is on sale @ $290 M. $200 will buy ____ of these boards. — 114

12. A particular grade lumber retails for .50 a board foot. Bought in quantities of 1000 board feet is discounted 20%. How much would it cost to buy 1,000 board feet? — $400.00

13. A wood frame house measures 32' x 48'. A double 2 x 12 built-up girder bands the perimeter of the house. How many board feet are in the girders? Figure full lengths each side. — 640

14. Cross-bridging requires a 1 x 4 x 18" lg. each piece. 128 pieces of bridging are required. How many board feet are required for bridging? How many 1 x 4 x 12" lg. pieces of lumber are required to make the bridging? — 64 bd. ft. / 16 pcs.

15. A building contractor worked on a cost plus 15% basis. The building contracted cost $87,000.00. The contractor's profit margin was ____. — $13,050.00

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

III-A-1(S)

TASK:	Install Sills And Headers On Foundation Walls - Platform Framing
AIM:	The student(s) will be able to correctly install sill plates and headers for platform framing on a wall type foundation.
TOOLS AND EQUIPMENT:	Try-square, pencil, claw hammer, brace, 7/8" bit, box or open-end wrench for nuts, cross-cut hand saw, straightedge, carpenter's level
MATERIALS:	As per details and specifications - framing lumber, sill sealant, termite shield (optional), flat washers and nuts for anchor bolts, 10d and 16d common nails
TEACHING AIDS:	Blueprints and Specifications, Job and task sheets III-A-1(J), III-A-1, 1a, 1b,(TS)
REFERENCES:	Wagner, Willis H., Modern Carpentry
PREREQUISITE EXPERIENCE OF THE LEARNER:	The student must have successfully completed related lessons III-A-1(I), Framing Lumber; III-B-1(I), Types of House Framing; III-B-2(I), Types of Floor Framing
CHECKING STANDARDS:	1. Material selection and placement 2. Accuracy of layout for anchor bolt holes 3. Installed sill properly positioned, flat, level, firm 4. Header properly positioned, nailed

I. PREPARATION (OF THE LEARNER - MOTIVATION)

The sill or sill plate is the first framing member positioned in a wood frame structure on wall foundations. Since it is the first, it is perhaps the most important as it acts as the base for the rest of the wood frame construction.

The accuracy with which the sill is framed is of great importance to the success of framing the entire building. The dimensions given on the architect's plans and details should be studied closely so that the sill may be properly placed on the foundation wall.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. Select Sill Material	1. As per details and specifications 2. Generally 2 x 6 or 2 x 8 stock 3. Often treated 4. Use 14' or 16' lengths where possible 5. Straight, little or no warpage
2. Straighten Bent Anchor Bolts	1. As necessary 2. Thread nut on bent anchor bolt 3. To full thread engagement

4. Tap side of nut and anchor bolt with hammer
5. In direction to straighten bolt vertically
6. Check with try square

3. Position Sill Material
1. Along top of foundation walls
2. One wall at-a-time
3. Flat against inside of anchor bolts
4. Ends square, joints butted flush; with
   a. No joints over openings in foundation walls
   b. At least two anchor bolts for each material length

4. Mark Sill For Anchor Bolt Holes
1. With try square and pencil
2. Mark lines on face of sill
   a. Parallel and square to edge of sill
   b. Each side of each anchor bolt
3. Measure distance
   a. From outside edge of foundation wall
   b. To the center of each anchor bolt
   c. One bolt at-a-time

Note: If the outside edge of the sheathing is to be flush with the outside of foundation wall subtract thickness of sheathing from the measured distance (keypoint # 3)

4. Mark distance on sill
   a. With a line between parallel lines
   b. Parallel to and measured from the outside edge of the sill
   c. Each anchor bolt, one-at-a-time
5. Locate centers for holes
   a. On measured distance from outside edge of sill
   b. Halfway between parallel lines

5. Drill Anchor Bolt Holes
1. 1/4" - 3/8" diameter larger than anchor bolts
2. Centered on points marked
3. Straight and square with sill

6. Install Sill Sealant

Note: 1. If termite shields are employed, install at this time. Use same hole pattern
2. As there are several types and preferences of sealant, follow the manufacturer's recommendations for installation

7. Position And Secure Sill
1. Place sills over anchor bolts
2. Place washers and nuts on anchor bolts
3. Align sill to be level and straight with outside face of foundation wall

	4. Draw nuts down to hold sill firm but not out of alignment
8. Check Level And Flatness	1. Use straight edge and level a. Place straight edge along sill lengths, across corners b. Place level on top of straight edge 2. Shim as required to level a. Loosen anchor nuts slightly in low areas b. Shim with wedges c. Grout for solid base
9. Install Headers	1. Measure and cut to length; square 2. Position on edge a. Flush to outside edge of sill b. Edge butt flush at corners 3. Toenail to sill from outside a. Use 10d common nails b. On 16" centers approximately 4. Spike corners to header joist a. Use 16d nails (2) b. Centered on header joist

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

Instructor demonstrate proper procedure (steps and keypoints) of installing sill and header

Instructor pass out job and task sheets

Students practice job and tasks under supervision of instructor

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

Performance Test!

Students install sill plates and headers according to blueprints and specifications

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

The sill is the first framing member placed in a wood frame structure on wall foundations. The accuracy with which the sill is framed is of great importance to the success of framing the entire structure.

Material selected should be straight with few or no defects. Full lengths should be used where possible and joints should be butted close with at least two anchor bolts holding each piece of sill material.

Anchor bolt holes are marked individually with the sill plate positioned adjacent to, and in proper alignment with, the anchor bolts; then drilled 1/4" - 3/8" oversize to allow minor alignment upon installation.

Clean foundation tops level and true, install sill sealer and place the sill over the anchor bolts. Align the sill plate and draw the nuts down to hold plate firm.

Check the sill for level and flatness using a straightedge and a carpenter's level. Loosen anchor nuts in low areas and shim as necessary to level. Grout any voids for a solid base.

Place the header so that is stands square and flush with the faces of the wall and at the ends. Toenail in place using 10d common nails on 16" centers.

SUGGESTED READING FOR THE STUDENT:

Modern Carpentry, Unit 7

THE NEXT LESSON IS: III-A-2(S), Install Girders and Beams

JOB SHEET
IN
PLATFORM FLOOR FRAMING

III-A-1(J)

NAME OF JOB:	Install Sills And Headers On Wall Type Foundations
DRAWINGS:	Blueprint floor plan, foundation plan, elevations and details
MATERIALS:	As per specifications and details - framing lumber, sill sealant, washers and nuts for anchor bolts, 10d and 16d common nails
TOOLS AND EQUIPMENT:	Try square, pencil, claw hammer, brace, 7/8" bit, box or open-end wrench, cross-cut hand saw, straightedge, carpenter's level
GENERAL INSTRUCTIONS:	Study the plans and specifications. Determine material type and size - determine most appropriate lengths; where best to place joints in sills; use 14' - 16' lengths where possible. Select sound material with little or no warpage - place it flat on top of wall against the inside of the anchor bolts. Transfer bolt hole locations to the sill accurately and drill anchor bolt holes 1/4" to 3/8" oversize. After drilling holes, clean top of foundation wall, position sill sealant, place the sill over the anchor bolts and align. Add washers and nuts and draw sill down firm against foundation. Check sill for level and flatness - shim to level as required and fill any openings with grout.
PROCEDURE AND/OR TASKS:	III-A-1(TS), Lay Out And Mark Sill Plates III-A-1a(TS), Install Sills III-A-1b(TS), Install Headers

TASK SHEET III-A-1, (3)

TASK: Lay Out And Mark Sill Plates

JOB: Install Sills And Headers - Platform Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: Framing lumber as per blueprints and specifications, try-square, pencil

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Study Plans And Specifications	1. Determine material type and size 2. Familiarize self with details, dimensions 3. Determine locations of sill joints
2. Select Material	1. Size, type as per specifications and details 2. Use 14' - 16' lengths where possible a. At least 2 anchor bolts each material length b. No sill joints over openings in foundation walls 3. Straight - little or no warpage
3. Position Material	1. Flat; on top of foundation wall 2. Against inside of anchor bolts 3. Ends of sills may be left projecting over the wall or . . . 4. Ends squared flush with wall or previously placed sill
4. Mark Material	1. Use try square and pencil 2. Square lines across sill plate a. Flush at ends of wall or . . . b. Flush with inside of previously laid sill plate c. On each side of each anchor bolt 2. Measure correct distance in a. From outside of foundation wall b. To center of each anchor bolt 3. Mark with a line between squared lines 4. Locate bolt hole centers a. With an X b. On measured line c. Halfway between squared lines

TASK SHEET III-A-1a(TS)

TASK: Install Sills

JOB: Install Sills And Headers - Platform Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: Try square, pencil, bit brace, 7/8" dia. bit, hand cross-cut saw, box or open-end wrench to fit anchor bolt nuts, carpenter's level, 25' steel tape measure

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Drill Anchor Bolt Holes	1. 1/4" - 3/8" larger than anchor bolts 2. Straight and vertical with sill 3. Centered on points marked
2. Square Ends Of Sills	1. To fit flush at ends on wall 2. To butt together closely at corners, joints Note: If termite shields are used - install at this time. Use same hole pattern! If foundations are level and true, a sill sealer strip may be used and should be installed at this time.
3. Position And Secure Sill	1. Place sills over anchor bolts 2. Place washers and nuts on anchor bolts 3. Align sills a. Outside edges flush with wall b. Joints, corners butted flush 4. Draw nuts down to hold sill firm, flat
4. Check Level And Alignment	1. With straightedge, carpenter's level a. Check level along sill lengths b. Check level across corners 2. With steel tape a. Check corners for square (6,8,10, method) b. Check out-to-out dimensions
5. Shim To Level	1. With straightedge in place 2. Loosen anchor bolts slightly in low areas 3. Shim as required with wedges 4. Grout for solid base

TASK SHEET III-A-1b(TS)

TASK: Install Header

JOB: Install Sills And Headers - Platform Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: Framing square, hand cross-cut saw, claw hammer (13 oz.), 10d common nails

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Select Material	1. Size and type as per specifications 2. Lengths full where possible 3. Straight - little or no warpage
2. Square Ends	1. Check with framing square 2. Mark and cut square if necessary
3. Place Header	1. On edge, square with sill 2. Flush with outside of sill and wall 3. Flush at end of sill and wall
4. Secure Header	1. While holding in position 2. Toenail with 10d nails 3. Spaced 16" on centers 4. So it stands squarely with the face of the wall

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

III-A-2(I)

SUBJECT:	Plywood and Processed Wood Panels
AIM:	The students will be able to identify various types and grades of fabricated wood panels and list examples of the use of each in building and construction.
TEACHING AIDS:	Information Sheet III-A-2(IS), chalkboard/chalk
MATERIALS:	Samples of different types of plywood; engineered board, samples showing different core construction
REFERENCES:	Wagner, William H., Modern Carpentry, Unit 4 Feirer, John L., and Hutchings, Gilbert R., Guide To Residential Carpentry, Unit 3
PREREQUISITE EXPERIENCE OF THE LEARNER:	The student must meet the requirements of the Texas Education Agency and the local school district; display a sincere interest in learning the building trades; and have successfully completed Major Block I, "Orientation And Safety."

I. PREPARATION (OF THE LEARNER - MOTIVATION)

Although plywood had been around for some time, it did not become a popular building material until after World War II, during which the government proved its worth as a building material.

Out of necessity and expedience, plywood was employed in the design and construction of "modular" buildings for military bases, desperately needed during the early war years. The Navy turned to plywood for the construction of PT (torpedo) boats and smaller craft when metal was scarce, and Howard Hughes built his famous "Spruce Goose" of plywood for its lightness of weight and strength. Many applications of plywood were tried and tested! Many stuck! The modular construction method has become a principal design technique for building and has had a major effect on standardizing sizes of many building materials.

Today, plywood and other processed wood panels are a major building material. It is used as foundation forms, sub-floors, wall and roof sheathing, framed trusses, exterior siding, interior paneling, furniture, and cabinetmaking, to name a few. For these reasons, the student of building trades should have a good working knowledge of plywood: the types, grades; sizes; workability.

II. PRESENTATION (OF THE INFORMATION)

A. Plywood
   1. Construction

Passout: III-A-2(IS)

1. Is a fabricated sheet material
2. Is constructed two basic ways
   a. Veneer core
   b. Solid core
3. Veneer core
   a. Constructed from thin sheets of wood
   b. Sheets rotary cut (peeled) from logs are called plies
   c. Plies stacked cross-grain for strength and stability

d. Always constructed in odd number of plies
1.) For balanced construction
2.) So grain of outside plies are parallel to length
e. Bonded under heat and pressure
f. Trimmed (cut) to standard size sheets

Note: Plywood thickness determines number of plies

4. Solid core
a. Constructed of narrow solid wood strips
1.) Arranged to equalize stress
2.) Edge glued into panels
b. Covered with cross-band, face veneer each side
c. Bonded into solid sheet under pressure
d. Trimmed to standard size

2. Sizes

1. Standard width and length, 4' x 8'
2. Extra length on special order, 10',12', 14', 16'
3. Standard thicknesses
a. 1/8" to 3/8" in 1/16" intervals
b. 3/8" to 1½" in 1/8" intervals
c. 1/4", 3/8", 1/2" 5/8", 3/4" commonly available in lumber yards

3. Types

Show: Samples

1. Two broad classifications
a. Hardwood plywood
b. Softwood plywood

Note: Over 70 different wood species including some 30 species of softwood, native, and imported hardwoods are used in manufacturing plywood

2. Softwood plywood grouped into 4 groups
a. Groups based on stiffness
b. Group I stiffest
c. Group IV least stiff
3. Two major types

Note: Type refers to "moisture resistance" of plywood

a. Exterior - will retain its shape and strength when exposed to water and weather
b. Interior - will withstand occasional wetting if not allowed to remain so for long periods
4. Major difference in type of glue used for bonding plies

4. Grades
   1. Grades are determined by the quality of the surface veneer
   2. Grading system established by the Department of Commerce
   3. American Plywood Association helped establish rules
   4. Plywood graded under system is stamped DFPA, "Division For Produce Approval"
   5. Softwood plywood manufactured in accordance with product standard PS-1-74
   6. Softwood grades are designated by letters A,B,C,D, and N
      a. Grade A - top standard grade
      b. Grade D - bottom standard grade
      c. Grade N - special order

5. Advantages
   1. Strength in both directions
   2. Dimensional stability
   3. Wide selection of surface treatments
   4. Available in many grades and species
   5. Large sheets reduce construction/assembly time - production costs are less
   6. Can be bent to form irregular shapes

6. Major Uses
   1. Concrete forms - very adaptable; may be reused as sheathing
   2. Sub-floors - provides firm, smooth base for flooring
   3. Wall sheathing - produces walls that are warm, strong, rigid
   4. Roof decking - adds strength; rigidity
   5. Interior paneling - provides warmth of real wood
   6. Exterior siding - several smart styles; fits many modern and rustic homes
   7. Cabinets and built-ins

7. Purchasing
   1. Generally purchased in full sheet size
   2. Sold by the square foot
   3. Thickness, grade, core, type determined by purpose for which it will be used
   4. When ordering, specify:
      a. Number of pieces
      b. Thickness, width and length
      c. Surface grades (front and back)
      d. Species of wood (surface)
      e. Type (adhesive requirement)

8. Working Plywood
   1. Sawing
      a. Use fine tooth hand saw, 10-15 points
      b. Use sharp combination or ply-tooth blade in circular saw
      c. Turn good face of plywood to receive cutting stroke

2. Planing edges
   a. Always plane from ends toward center
   b. Use plane with sharp blade
   c. Take shallow cuts
3. Using nails and screws

Note: Nails and screws do not hold well in the edge of plywood

   a. Select nails and screws as follows:

Plywood	Nail	Screw
3/4"	6d casing	No.8 - 1½"
5/8"	6d	No.8 - 1¼"
1/2"	4d	No.6 - 1¼"
3/8"	3d	No.6 - 1"
1/4"	1" brad	No.4 - 3/4"

   b. Pre-drill slightly smaller pilot holes
   c. Space fasteners 6"-8" apart
   d. Use in conjunction with glue for extra strength
   e. Countersink heads and apply filler
4. Drilling
   a. Use sharp, clean drill
   b. Use backing block when drilling thru plywood
   c. Ease drill thru face veneer
5. Storing
   a. Lay sheets flat
   b. Store in dry area

Note: If plywood must be stored on edge, support in vertical position

B. Hardboard

1. Is a by-product of the lumber industry
2. Is made from inferior logs, sawmill discards and residue
3. Is a manufactured wood sheet material
4. Is made in standard sheet sizes similar to plywood
5. Is available with large selection of surface treatments and textures

1. Manufacture

1. Logs cut into wood chips
2. Chips, residue reduced to fibers
   a. By steam
   b. By mechanical processes
3. Fibers are mixed with certain chemicals and lignin (natural cementum) for a bonding agent
4. Fibers are pressed into a dense strong sheet under extreme pressure

2. Types

1. Two major types
   a. Type I - standard
   b. Type II - tempered

2. Type I standard divided into two classes according to strength
   a. Class 1 stronger than class 2
   b. Both are used where there is no hard wear or extreme humidity
3. Type II tempered is treated and baked with special compounds to:
   a. Increase its strength
   b. Provide high abrasion resistance
   c. Improve moisture, weather resisting qualities
4. Many surface treatments and appearances

3. Sizes
1. Thicknesses - 1/10" to 5/16"
2. Common thicknesses 1/8", 3/16", 1/4"
3. Widths - standard; 4' panels
4. Lengths - standard; 6', 8', 10', 12', 16'

4. Uses
1. Wall, ceiling paneling
2. Doors, partitions, built-ins, cabinets
3. Exterior siding
4. Furniture drawers, backs

5. Working Hardboard
1. Is similar to plywood
2. Sharp woodworking tools may be used
3. Carbide tipped tools preferred

Note: Bend in one direction only. Never attempt to make a compound bend

C. Particle Board
1. Another by-product of lumber industry
2. Is a result of wood technology - developed since 1948
3. Combines sorted wood chips and special phenolic resins (clear adhesives)
4. Bonded under heat and pressure into sheets
5. Results in a manufactured structural material displaying real wood in blended form

1. Advantages
1. Economics - more economical than plywood
2. Very stable - affected little by humidity
3. Noted for its surface smoothness
4. Good screw and nail holding power

2. Sizes
1. Thicknesses - 1/8" to 1 7/16"
2. Standard sheets 4' x 8'; 5' x 8' sheets special

3. Uses
1. Used extensively as underlayment for:
   a. Floors
   b. Countertops
   c. Cabinets and built-ins

	2. Core stock in furniture 3. Some paneling
4. Working Particle Board	1. Use standard woodworking tool 2. Carbide tipped tools recommended for large volume cutting

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS, OR ASSIGNMENTS MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

Field Trip! Local plywood, hardboard, or particle board manufacturer.
Make plans and arrangements for trip!
Discuss trip with students: purpose, schedule, conduct, safety, what to look for, parental permission.
Take trip!
Review trip with students: class discussion, oral questions.

Guest Speaker: Local plywood association representative

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENT'S COMPREHENSION OF MATERIALS PRESENTED.)

True - False

1.	Plywood is a fabricated wood product made from inferior logs and sawmill discards.	F
2.	Plywood was developed out of necessity for quick buildings during World War II.	T
3.	The Navy used plywood in the construction of torpedo boats and light craft during World War II.	T
4.	The use of plywood and the modular construction method have had a major effect on standardizing sizes of many building materials.	T
5.	Plywood is manufactured to specification standards established by the Department of Interior.	F
6.	Some 30 species of native softwood are made into plywood.	T
7.	The major difference between interior and exterior plywood is the type glue used.	T
8.	DFPA stands for "Douglas Fir Plywood Association".	F
9.	American Plywood Association members manufacture plywood under the product standard PS-1-74.	T
10.	Plywood is always made with an even number of piles.	F
11.	Plywood grades are determined by the quality of the surface veneer.	T
12.	Softwood plywoods carry a number grade.	F

IV. VERIFICATION (CONT'.) III-A-2(I)

13. Plywood is sold by the square foot. T
14. Plywood is available in standard 4' x 8' sheets. T
15. Hardboard is a fabricated wood product made from sawmill discards and residue. T
16. Hardboard is wood reduced to a fibrous state and bonded under heat and pressure into sheets up to ¼" thick. F
17. Type I hardboard is tempered to resist abrasion and moisture. F
18. Particle board may be obtained in 1¼" thickness. T
19. Particle board is often used as underlayment for countertops and cabinets. T
20. Plywood, particle board, and hardboard are all lumber by-products. T

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

Out of necessity and expedience, the U.S. government employed the use of plywood during the war years (World War II). At first, for the design and construction of modular buildings for badly needed military bases, and later for PT (torpedo) boats when metal was scarce. Howard Hughes built his "Spruce Goose", a gigantic aircraft, of plywood for its strength and lightness of weight. Many applications of plywood were tried and tested. Many stuck!

Today plywood and other processed wood panels are a major building material. Found in practically every lumber yard and on every type construction, it is used in almost every application from foundation forms to fine furniture.

Plywood is a fabricated sheet material made of thin sheets of wood, or plies, that have been rotary turned (peeled) from logs, stacked cross-grain to each other, and laminated (glued) together under heat and pressure into flat sheets. Plywood is made from over 70 different wood species that include both hardwood and softwood and is classified into two major types: exterior and interior. The major difference is in the type glue used. While hardwood plywood is used extensively for fine wall paneling and furniture, softwood plywood is used in building and construction.

Softwood plywood is divided into four groups based on stiffness - group I being the stiffest, and group IV the least stiff. Five grades designate surface quality. Surface grades are assigned letters A, B, C, D; A being the top standard grade; D being the lowest, or utility grade. N is a special order grade.

Other fabricated wood products in sheet/panel form are hardboard and particle board. These are both outgrowths of the lumber/plywood industry and the result of modern technology looking to utilize waste of sawmill discards, residue, and inferior logs.

Hardboard is produced by reducing these waste materials to wood fibers and bonding them in flat sheets under heat and pressure using lignin (natural

cementum) as the bonding agent. These sheets are manufactured in thicknesses from 1/10" to 5/16" and in standard panels 4' x 8'. There are two types of hardboard: Type I, standard; and Type II, tempered. Tempered hardboard has had certain chemicals added to increase its ability to resist abrasion and humidity (moisture).

Particle board is produced by reducing inferior logs and wood scrap to chips of the proper size, adding special phenolic resins (clear adhesives), and bonding into flat sheets under heat and pressure. The result is structural panels in practically every size as plywood displaying real wood surfaces in blended form.

Both hardboard and particle board possess many of the qualities of plywood (strength) both directions and dimensional stability, may be worked like plywood, and may be used in many of the same applications, especially as underlayment.

SUGGESTED READING FOR STUDENTS:

Modern Carpentry, pp. 62-65
Woodworking For Industry, Units 11, 12

THE NEXT LESSON IS: III-B-1(I), Types of House Framing, Framing Components

INFORMATION SHEET
ON
PROCESSED WOOD PANELS

III-A-2(IS)
(p. 1 of 3)

SUBJECT: Plywood, Hardboard, and Particle Board

INTRODUCTORY INFORMATION:

Although plywood had been around for some time, it did not become a popular building material until after World War II, during which the government proved its worth as a building material.

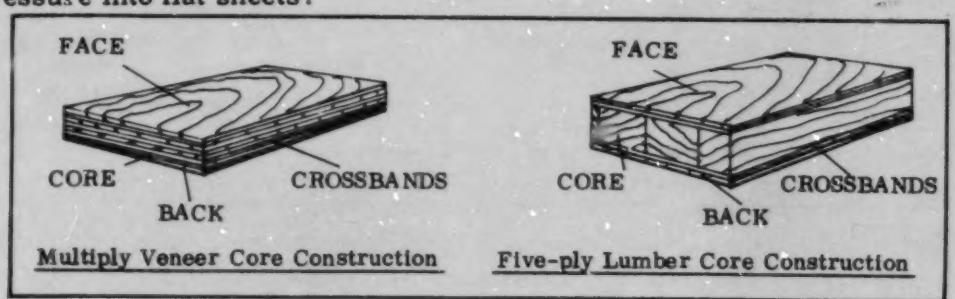
Out of necessity and expedience, plywood was employed in the design and construction of "modular" buildings for military bases, desperately needed during the early war years. The Navy turned to plywood for the construction of PT (torpedo) boats and other small craft when metal was scarce; and Howard Hughes built his famous "Spruce Goose" of plywood for its lightness of weight and strength. Many applications of plywood were tried and tested. Many stuck! The modular construction method has become a principal design technique for building and has had a major effect on standardizing sizes of many building materials.

Today plywood and other processed wood panels are a major building material. Found in practically every lumber company and every type construction, it is used for almost every application from foundation forms to fine furniture.

GENERAL INFORMATION:

Plywood is made from over 70 different wood species including some 30 different softwoods, native and imported hardwoods. Selection of plywood, type, construction, surface grain, and quality is wide and varied to meet its many and varied applications.

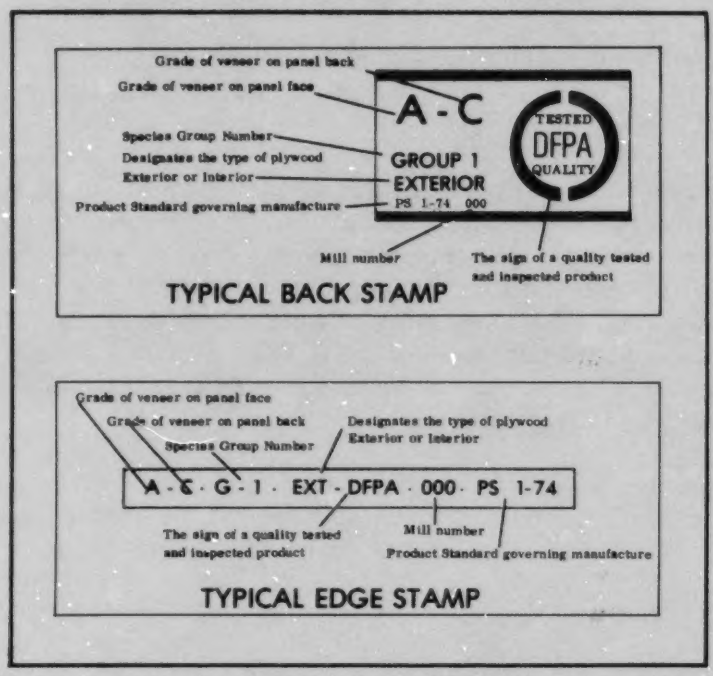
Plywood is fabricated wood panel constructed of layers - plies of wood veneer, or wood veneer and a solid wood core - stacked cross-grain and laminated under heat and pressure into flat sheets.



Plywoods are made in two basic types: exterior and interior. The major difference

is in the type of glue used for bonding the plies. Exterior plywood employs a completely waterproof glue, while interior plywood uses a highly moisture resistant glue.

Softwood plywood is manufactured in accordance with Product Standard PS 1-74 established by the U.S. Department of Commerce, which provides a system for designating the species, strength, type glue, and appearance.



Plywoods graded by these standards carry a DFPA tested quality stamp which stands for "Division For Product Approval." The stamp also includes a group number.

GROUP 1	GROUP 2		GROUP 3	GROUP 4
Douglas fir 1	Cedar, Port Orford	Hemlock, Western	Alder, red	Cedar
Larch, Western	Douglas fir 2	Lauan	Cedar, Alaska yellow	Incense
Pine, Southern	Fir	Red	Pine	Western red
Loblolly	California red	White	Lodgepole	Fir, subalpine
Longleaf	Grand	Pine, Western white	Ponderosa	Pine, sugar
Shortleaf	Noble	Spruce, Sitka	Redwood	Poplar, Western
Slash	Pacific Silver			Spruce, Engelmann
Tanoak	White			

Douglas fir 1 - Washington, Oregon, California, Idaho, Montana, Wyoming, British Columbia, Alberta.

Douglas fir 2 - Nevada, Utah, Colorado, Arizona, New Mexico.

Softwood plywoods are classified by species into four groups according to strength and stiffness: group I being the stiffest, group IV being least stiff, and five grades according to quality of the panel faces. The five grades are identified with the letters A, B, C, D, and N. "A" is the top standard grade and "D" the bottom standard grade. "N" is a special order grade.

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GRADE	SURFACE VENEER DESCRIPTIONS
N	Special order "natural finish" veneer. Selected all heartwood or all sapwood. Free of open defects. Allows some repairs.
A	Smooth and paintable. Neatly made repairs permissible. Also used for natural finish in less demanding applications.
B	Solid surface veneer. Circular repair plugs and tight knots permitted. Can be painted.
C	Minimum veneer permitted in Exterior type plywood. Knotholes to 1". (Occasionally knotholes ½"-larger permitted providing total width of all knots and knotholes within a specified section does not exceed certain limits.) Limited splits permitted.
C plugged	Improved C veneer with splits limited to ⅛" in width and knotholes and borer holes limited to ¼" by ½".
D	Used only in Interior type for inner plys and backs. Permits knots and knotholes to 2½" in maximum dimension and ½" larger under certain specified limits. Limited splits permitted.

Plywood is made in standard 4' x 8' panels with additional lengths to 10', 12', and 16' available on special order. Panel thicknesses range from 1/8" to 1½" with common thicknesses of 1/4", 3/8", 1/2", 5/8", and 3/4" readily available.

Other processed wood products in structural panel form are "Hardboard" and "Particle board." These products are used in many of the same ways as plywoods and, in fact, are an outgrowth of the lumber industry as is plywood.

Developed as a scientific endeavor to reduce the costly waste of sawmills, hardboard is manufactured from sawmill scrap and residue, reduced to wood fibers and bonded together with lignin (the natural cementum existing in all woods) under extreme pressure. The result is a dense, flat, structural panel which has no knots or grain; can be used in many of the same applications as plywood; is worked similarly to plywood, and is economical. Today, hardboard is manufactured in two types, standard and tempered; tempered having certain chemicals added during manufacture to make it more abrasion and moisture resistant, and in a wide array of surface finishes and textures. The thicknesses most often available are 1/8" and 1/4" in sheet sizes of 4' x 8'.

Particle board is another processed wood product which can be purchased in standard 4' x 8' panel size with thicknesses from 1/8" to 1 7/16". Particle board is made from sawmill scraps and poor quality saw logs which would otherwise be wasted, by chipping the wood into uniform sized flakes, mixing with special phenol resins and glues, and pressing them into flat sheets using a conventional multi-platen hot press. The result is a structural panel which is strong and very stable - affected little by humidity, temperature, and displays real wood surfaces in a blended form. It is used extensively in house construction as underlayment for floors and counters, and often in furniture construction.

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INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

III-A-2(S)

TASK:	Frame Girders And Beams On Pier Foundations
AIM:	The student(s) will be able to properly frame and install girders and beams on pier foundation using flat bar anchors aligned 3" inside of building lines.
TOOLS AND EQUIPMENT:	Chalkline, 25' measuring tape, framing square, pencil, cross-cut saw, straightedge, carpenter's level, claw hammer, chisel, pointing trowel
MATERIALS:	As per details and specifications - framing lumber, 20d casing nails, portland cement
REFERENCES:	Wagner, Willis H., Modern Carpentry
PREREQUISITE EXPERIENCE OF THE LEARNER:	The student must have successfully completed related lessons III-A-1(I), Framing Lumber, III-B-1(I), Types of House Framing, III-B-2(I), Types of Floor Framing
CHECKING STANDARDS:	1. Material selection - size, type 2. Arrangement and placement of material a. Crowned edges up b. Joints staggered over piers c. Corners as per detail 3. Girder construction a. Tops flush b. Nailed solid 4. Location and alignment a. As per plans and details b. Anchored firm

I. PREPARATION (OF THE LEARNER - MOTIVATION)

With a pier type foundation, sills are replaced by girders. Girders are large horizontal support members which span from one column (pier) to another to support floor joists, walls, and loads imposed by the superstructure. In homebuilding, girders and beams are usually built on the site using three (3) 2" planks nailed together with 20d common nails.

The carpenter must read and interpret blueprints, then follow certain procedures in the construction and framing of girders and beams to satisfactorily meet the requirements of the architect.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. Select Beam Material	1. As per details and specifications a. Size as per specifications b. Lengths as per dimensions

	2. Standard lengths where possible 3. Straight, little or no warpage
2. Position Two Outside Members	1. On piers 2. On edge with crowns up 3. Outside edge, ends to building lines marked with chalkline 4. Inside member of partial girder butted flush against flat bar anchors in foundation piers
3. Check Alignment	1. Ends butted flush 2. Joints staggered over piers 3. Crown edges held flush
4. Nail Outside Members Together	1. Use 20d common nails 2. Two near each end; each piece 3. Stagger intermediate nails a. Alternately on opposite edges b. Spaced approximately 30" 4. Turn nails protruding through material
5. Fasten Partial Girder To Anchors	1. Recheck alignment and position 2. Check girder flatness and level a. Use straightedge and carpenter's level b. Shim as necessary to level 3. Nail anchors to inside of partial girder 4. Use 20d common nails
6. Position Inside Member	1. On piers 2. Against opposite side of flat bar anchors 3. Aligned as in step #3 above 4. With crowned edge up
7. Mark And Notch Member	1. To receive the flat anchor bar 2. The location and size of the anchors 3. To allow members to fit flush against each other
8. Nail Inside Member	1. To partial girder completing girder 2. Use 20d common nails 3. Use alternately opposite nailing pattern as outside 4. While holding top edge (crown) flush
9. Grout	1. With portland cement 2. Any voids between girders and piers 3. To provide a solid base

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION) III-A-2(S)

Instructor demonstrate proper procedure (steps and keypoints) for constructing a built-up girder on the job site

Instructor pass out job and task sheets

Students practice job and tasks under close supervision of instructor

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

Performance Test!

Students construct and frame girders for wood frame house on pier foundation according to blueprints and specifications

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

Girders are horizontal beams which replace the sills of a floor frame constructed on pier type foundations. Girders are large horizontal support members which span from one column or pier to another to carry floor joists, walls, and loads imposed by the superstructure.

In homebuilding, girders are usually of the built-up type, built of three 2" pieces of lumber nailed together, and are generally constructed on the site.

Before starting construction study the blueprints and specifications: note material type and size; length of spans; method of anchoring, construction of corners. Become familiar with the requirements for that girder.

Select and position the material to meet the girder requirements: size and type according to specifications; straight with little or no bow; lengths standard where possible or with little waste to properly stagger joints over piers, corner details as per plans.

Position material on piers, on edge with crowned edge up. Start at one corner and work along one side - place outside member on building line and stagger joints over piers.

When beam members are properly positioned with their top edges flush, nail outside members to center member using 20d commons, two near each end of each piece, others staggered approximately 30" apart.

Level the girder from pier to pier and grout with portland cement. Attach to anchors as per details. Note: Leveling and attaching to anchors may come during construction or after construction depending on the type anchors employed.

SUGGESTED READING FOR THE SUTDENT:

Modern Carpentry, Unit 7

THE NEXT LESSON IS: III-B-1(S), Install Floor Joists

JOB SHEET III-A-2(J)
IN
PLATFORM FLOOR FRAMING

NAME OF JOB:	Construct Built-Up Floor Girders On Pier Foundations
DRAWINGS:	Blueprint floor plan, foundation plan, elevations, details
MATERIALS:	Framing lumber as per blueprints and specifications, 20d casing nails, portland cement
TOOLS AND EQUIPMENT:	Chalkline, 25' measuring tape, framing square, pencil, cross-cut saw, straightedge, carpenter's level, claw hammer, chisel, pointing trowel
GENERAL INSTRUCTIONS:	Study the plans and specifications. Become familiar with the girder sizes, dimensions, and construction, especially the type of corners and method of anchoring. Select the material size and type according to specifications and use standard lengths where possible, with as little warpage as possible. Position and align the material so that the crowned edges are up and joints are staggered over support points (piers). Nail the members together so that the tops are flush. Use 20d nails staggered approximately 30". Level and anchor the girder as required to form a firm solid base on the building lines.
PROCEDURES AND/OR TASKS:	III-A-2(TS), Select And Position Material III-A-2a(TS), Nail Girder Components To Assemble, Level And Anchor Girder

TASK SHEET III-A-2(TS)

TASK: Select And Position Material

JOB: Construct Built-Up Floor Girder On Pier Foundation

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel measuring tape, framing square, cross-cut saw, chalkline, framing lumber as per blueprints and specifications

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Study Plans And Specifications	1. Determine girder size and length 2. Determine material type and size 3. Note method of anchoring, if any 4. Note corner construction, if any 5. Note length of spans 6. Establish material lengths; location of joints
2. Select Material	1. Size and type as per specifications 2. Lengths standard where possible 3. Stagger joints over piers 4. Straight - little or no warpage
3. Mark Building Lines On Piers	1. Establish building line points 2. At each corner foundation pier 3. Stretch chalkline from corner to corner 4. Snap chalkline on piers Note: Outside of piers may be flush to the building line rendering step # 3 unnecessary
4. Position Material	1. On piers 2. On edge 3. Side by side 4. With outside to building line marked by chalkline 5. With crowned edges up 6. With joints staggered over piers Note: Mark and cut square, ends of lumber to properly locate joints

TASK SHEET III-A-2a(TS)

TASK: Nail Girder Components To Assemble, Level And Anchor Girder

JOB: Construct Built-Up Girder On Pier Foundations

TRADE: Building Trades

TOOLS AND MATERIALS: Claw hammer, straightedge, carpenter's level, chisel, pointing trowel, framing lumber as per blueprints and specifications, 20d casing nails, portland cement

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Align Two Outside Members	1. As in task III-A-2(TS), step # 4 2. With tops of members even (flush)
2. Nail Outside Members	1. Together while holding in place 2. Use 20d common nails 3. Two near each end of each piece 4. Others staggered 30" apart 5. Turn protruding nails
3. Position Outside Members	1. On edge with crowns up 2. To building lines mark with chalkline 3. Against flat bar anchors in piers
4. Level Outside Members	1. From pier to pier 2. Use straight edge and carpenter's level 3. Shim as required
5. Nail Anchors To Outside Members	1. While holding in place 2. Use 20d common nails 3. Spike through anchor and outside members 4. Turn protruding nails
6. Position Inside Member	1. On edge with crown up 2. Properly alogn as per task III-A-2(TS), step # 4 3. On inside against anchors
7. Mark And Notch Inside Member	1. To receive flat bar anchors 2. To allow inside member to position flush against outside members
8. Nail Inside Member	1. To outside members 2. While holding in place 3. Similar as step # 2 (outside) above
9. Grout	1. With portland cement 2. Any voids between girder and piers 3. To provide a solid base

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

III-B-1(I)

SUBJECT: Types of House Framing, Framing Components

AIM: The student(s) will be able to identify different types/methods of wood frame construction and the distinguishing characteristics; differences of each type.

TEACHING AIDS: Architectural prints and specifications, overhead projector; Transparencies I. ED. IV-18T, Part II, chalkboard, Information Sheet III-B-1(IS)

MATERIALS:

REFERENCES: Wagner, Willis H., Modern Carpentry, The Goodheart-Willcox Co., Inc., South Holland, Illinois
Jones, R.P., and Ball, J.E., Framing, Sheathing And Insulation. Delmar Publishers, Albany, New York
Feirer, John L., and Hutchings, G.E., Guide To Residential Construction, Bennett Publishing Company, Peoria, Illinois

PREREQUISITE EXPERIENCE OF THE LEARNER: Successful completion of Major Block II, "Foundations"
Prerequisites as set forth by local school, state school policy
Display sincere interest in learning building trades

I. PREPARATION (OF THE LEARNER - MOTIVATION)

The type, or method, of framing a house is determined by several factors. In a basic design the architect must consider such things as environment, weather, climate, soil, and topography. He/she must consider the loads that will be imposed; wind, snow, live and dead loads; and such things as the type space; its orientation; the type of material and its availability - all are weighed to determine the type of construction for a given situation.

The builder must recognize the type of construction employed in the architectural design and implement construction according to the architect's plans and details.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. Types	Note: Two major types discussed for purposes of conventional framing
Show Transparency Figs. 59, 60 61	1. Balloon framing 2. Platform framing - also called "Western"
B. Characteristics	1. Balloon framing a. Both wall studs and floor joists rest on the sill b. Studs are continuous from sill to rafter plates c. Upper floor joists supported by ribbon let into inside edge of wall studs

d. Floor joists (all) are spiked to studs to support and tie structure
e. Method requires installation of draftstop headers - firestops

2. Platform framing
a. Floor frames built as a platform each level
b. Platforms are built to building lines
c. Platforms provide a base on which to build wall sections one story high
d. Each floor is framed separately

C. Advantages

1. Balloon framing
a. Shrinkage reduced
1.) Lumber shrinks thru cross-section
2.) Lumber used in cross-section minimized
b. Greater vertical stability
1.) Less shrinkage vertically
2.) Lends itself to two-story brick veneer construction
c. Easy installation of service pipes and wiring in walls between levels

2. Platform framing
a. Standard materials more readily available; costs less
b. Platform provides convenient work area; high safety factor
c. Requires little, or no scaffolding
d. Allows prefabrication of wall sections
e. Cuts construction time
f. More economical

D. Disadvantages

1. Balloon framing
a. Quality studs at required lengths often at a premium
b. Construction/erection time greater
1.) Ribbon supports must be incorporated
2.) Draftstops, firestops must be added
3.) Walls sections cannot be prefabricated
4.) Requires additional scaffolding, bracing during construction
c. Work conditions more hazardous

2. Platform framing
Note: Has no appreciable disadvantages. Used in most modern home construction

E. House Frame Members
Show Transparency Figs. 3, 4, 5, 7, 8, 9, 11

1. Identify major house frame members
2. Explain purpose; function of each part
3. Show types, examples of each part

4. Floor frame parts
   a. Sills, headers
   b. Girders, beams
   c. Joists
   d. Bridging
   e. Sub-floor
5. Wall frame parts
   a. Sole, top plates
   b. Corner posts, partition T's
   c. Studs (regular, cripple)
   d. Trimmers, headers
   e. Braces, firestops
   f. Braces, sheathing
6. Roof framing
   a. Ceiling joists
   b. Rafters (hip, valley, jack)
   c. Ridge board
   d. Braces
   e. Decking

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS, OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

Field Trip! Major Housing/Apartment Development in framing stage
Make plans and arrangements for trip
Discuss trip with students: purpose; schedule; conduct; safety; what to look for! parental permission

Take Trip! Point out framing members; construction techniques; construction details

Review Trip! Class discussion

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENT'S COMPREHENSION OF MATERIALS PRESENTED.)

Essay Questions:

Explain the major differences between "Balloon" framing and "Platform" framing.

In balloon framing, the wall studs rest on the sill and are continuous from the sill to the rafter plate. Upper floor joists rest on a ribbon let-in to the inside edge of the studs, and all joists are fastened to the studs to support and tie the structure.

In platform framing, each floor is constructed as a platform complete with sub-floor. The platform serves as a safe working surface on which wall sections one story high may be fabricated and erected.

Explain the difference in "sill and beam" and "girder and beam" construction.

The difference lies in the type foundation on which the wood frame is constructed. In sill and beam construction, the sill is mounted on a wall type foundation. On a pier type foundation the sill is replaced by girders which will span from pier to pier and support the building loads.

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

Many factors are involved in determining the design and construction of a home. Wind, weather, soil, topography, live and dead loads, type of space and its orientation, type and availability of materials - all must be considered. The builder must read the architect's prints, recognize the type of construction, and implement that construction according to plans and details.

Two major types of house framing are "Balloon" framing and "Platform" framing. In balloon framing the wall studs rest on the sill. The wall studs are continuous from the sill to the rafter plates. Upper floor joists rest on a ribbon let-in to the inside edges of the studs, and all floor joists are fastened to the studs to support and tie the structure. In platform framing each floor is constructed as a platform complete with sub-floor. The platform serves as a safe working surface on which wall sections one story high can be fabricated and erected. Platform framing is the most popular type house framing in modern home construction. It incorporates the use of standard pre-cut studs; has a built-in safety factor in that it provides a platform at each level on which to work, requires less construction/erection time, and is therefore more economical.

The major parts of a wood house frame are floor frame, wall frame, and roof frame. Floor frame members include sills, headers, girders, beams, joists, bridging, and sub-flooring. Wall frame members include sole and top plates; corner posts and partition T's; studs - regular, trimmer, cripple; headers; braces - let-in, set-in; and sheathing. Roof frame members include ceiling joists, ridge board, rafters - common, hip, valley, jack, bracing, and decking.

SUGGESTED READING FOR STUDENTS:

Modern Carpentry, Unit 7
Fundamentals of Carpentry, Chapter 4

THE NEXT LESSON IS: III-B-2(I), Types of Floor Frames, Floor Frame Components

SUBJECT: Conventional Framing Types And Techniques

INTRODUCTORY INFORMATION:

Most homes in the United States and Canada are of wood frame construction. Wood frame homes are prevalent in these countries for several reasons. Wood is a native, natural resource to both countries. It is relatively strong, easy to work, and versatile, lending itself to this type of construction. It is reasonable in price and provides more house for a given cost. It serves to insulate, thereby increasing comfort to the occupants and reducing the cost of heating/cooling - and given proper care, it is durable, and will last a lifetime.

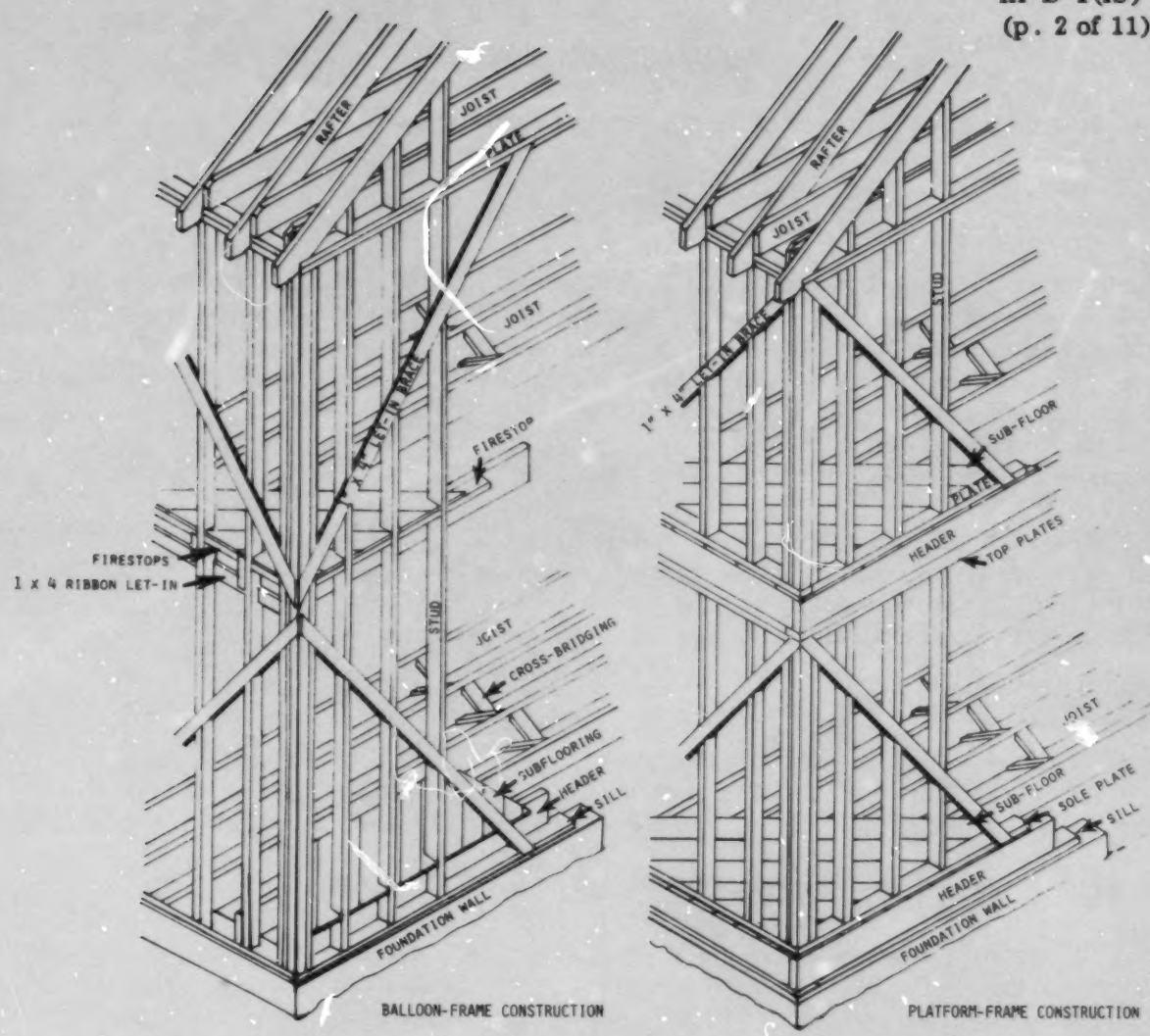
Buildings framed of lumber usually belong to one of two main classes:
*Plank-and-beam framing, which consists of heavy frame members, widely spaced with 2" floor and roof decking; and
*Multiple-member framing, often called "conventional framing".

GENERAL INFORMATION:

Conventional framing consists of multiple members - sills, joists, studs, plates, rafters, etc... joined together in such a way as to share the loads and support the structure. The two major types of conventional framing are balloon and platform.

In balloon framing, the features that identify this type construction are that the studs are continuous from the sill to the top plate. The studs and first floor joists rest on the sill, while the second floor joists bear on a 1"x4" ribbon let into the inside edges on the studs. All floor joists are spiked to the studs to stiffen and strengthen the framework, and blocks are placed between the joists to serve as solid bridging, firestops, and nailers.

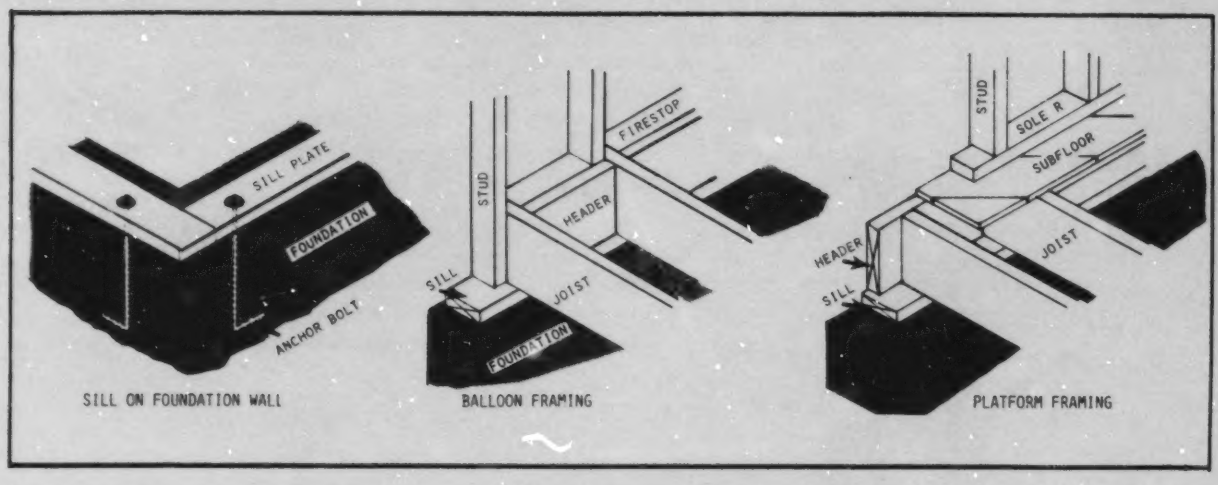
This type of framing is used less and less by today's modern home builder. The longer framing members required are not readily available - and construction time and material costs are greater. However, balloon framing does lend itself well to two-story construction, especially where the exterior is of stucco, brick, or stone veneer, in that there are fewer framing members to be borne upon in cross-section; the direction that wood contracts and expands.



In platform framing, the most popular form of modern home construction, the floor frame is constructed first - complete with sills, girders, headers, joists, bridging, and subfloor - and tied to the foundation by anchor bolts. The floor frame then serves as a platform on which to build wall frames one story at a time, on which a second floor frame may then be built. Platform framing has proved to be the most popular form of conventional framing in that it provides a solid, flat, work surface on which wall sections may be fabricated and erected; it has a built-in safety factor, especially at upper levels - no scaffolds or climbing around on framing members; it uses standard length framing materials, pre-cut studs which are readily available; and construction costs, time and material, are less.

Sills And Sill Headers

The sill or sill plate is the first member positioned in a wood frame structure on wall type foundations. The sills, usually 2"x6"s or 2"x8"s, rest flat on the foundation walls with outside edges on the building line. They are held in place by anchor bolts mounted in the foundation on approximately 6' to 8' intervals with at least two bolts in each sill plate. The sill acts as a base for fastening the rest of the frame to the foundation.



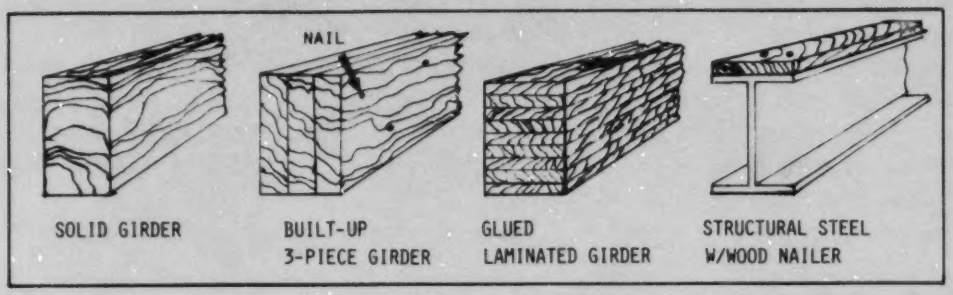
There are two types of wood sill construction over foundation walls - one for balloon framing and one for platform framing. Both types incorporate headers in their construction. Headers are horizontal framing members placed on edge atop the sill plate to support and enclose the floor joists.

In balloon framing, the "T" sill is used. The header is mounted on the sill plate flush to the inside of the studs, which rest on the sill plate flush to its outside. The header may be cut and fitted between the joists or be solid and spiked to the ends of the joists. The method used depends on the width of the sill, as the joist ends should bear on the sill plate at least 4".

The "L", or box, sill is used in platform framing. The header is mounted on the sill plate flush to the outside and is toenailed to the sill. The header encloses the floor joists and provides a rigid frame in which to spike the joist ends and nail the subfloor.

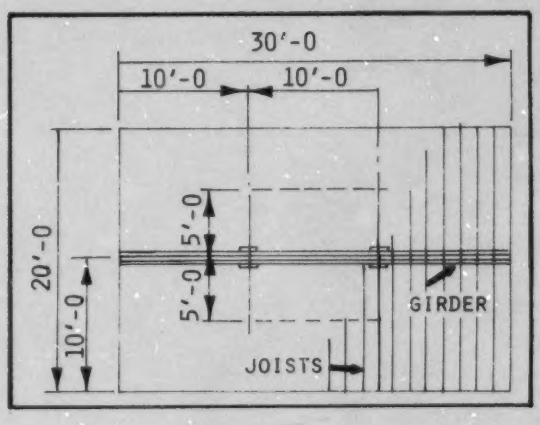
Girders And Beams

When wood frame construction is on pier type foundations, the sill or sill plates are replaced by girders. Girders are large principal beams used to support floor joists and the imposed loads of the building structure between piers. Common types of wood girders are solid, built-up, and laminated. In addition, structural



steel beams with wood nailers are often used as intermediate beams. The built-up girder is very commonly used in house construction. It is generally constructed of three (3) 2" planks nailed together with 20d nails on the site.

To determine the size of a wood girder, find the distance between the girder supports and the total floor area supported by the girder between supports. This will be one-half the span of the joists on either side of girder x the length between the girder supports.



Example:
One-half joist spans 5' + 5' = 10'
Lgth. between girder supports = 10' x
Total floor area supported = 100 sq '

Multiply the floor area by the total load per square foot on the floor (assume to be 40 lbs.). The total load on the girder above would compute to be 4,000 lbs. If the girder material is Douglas Fir or Southern Yellow Pine, look in 10' span column of the following chart. Follow the figures down until you find the figure 4000# or the next larger figure (4698) and look to the column at the left for the girder size.

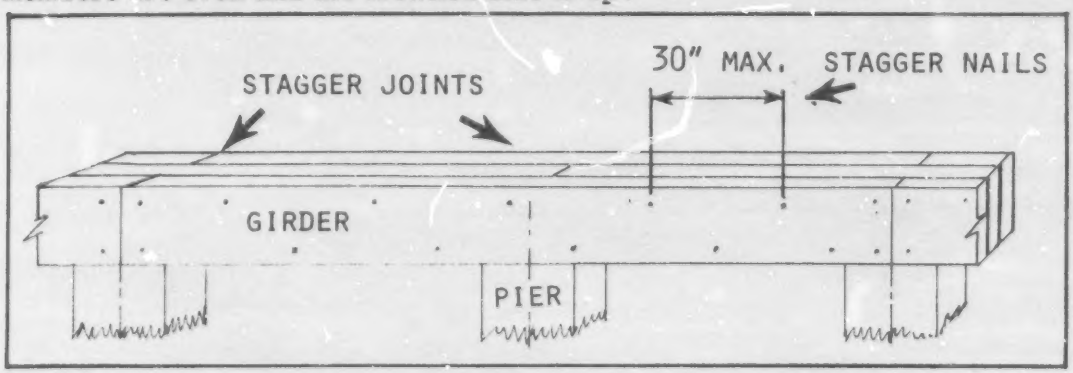
Allowable Uniformly Distributed Loads for Solid Wood Girders and Beams Computed for Actual Dressed Sizes of Douglas Fir, Southern Yellow Pine (Allowable Fiber Stress 1400 lbs. Per Square Inch)							
Solid Girder Size	Span in Feet						
	6	7	8	10	12	14	16
2 × 6	1318	1124	979	774	636	536	459
3 × 6	2027	1816	1581	249	1025	863	740
4 × 6	2936	2507	2184	1726	1418	1194	1025
6 × 6	4263	3638	3168	2504	2055	1731	1483
2 × 8	1865	1865	1760	1395	1150	973	839
3 × 8	3020	3020	2824	2238	1845	1560	1343
4 × 8	4165	4165	3901	3906	2552	2160	1802
6 × 8	6330	6330	5924	4698	3873	3277	2825
8 × 8	8630	8630	8078	6406	5281	4469	3851
2 × 10	2360	2360	2360	2237	1848	1569	1356
3 × 10	3810	3810	3810	3612	2984	2531	2267
4 × 10	5265	5265	5265	4992	4125	3500	3026
6 × 10	7990	7990	7990	6860	6261	5312	4593
8 × 10	10920	10920	10920	9351	8537	7244	6264
2 × 12	2845	2845	2845	2845	2724	2315	2006
3 × 12	4590	4590	4590	4590	4394	3734	3234
4 × 12	6350	6350	6350	6350	6075	5165	4474
6 × 12	9640	9640	9640	9640	9220	7837	6791
8 × 12	13160	13160	13160	13160	12570	10685	9260
2 × 14	3595	3595	3595	3595	3595	3199	2776

Built-up Girders: Multiply above figures by .897 when 4" girder is made of (2) 2" pcs.
Multiply above figures by .887 when 6" girder is made of (3) 2" pcs.
Multiply above figures by .867 when 8" girder is made of (4) 2" pcs.
Multiply above figures by .856 when 10" girder is made of (5) 2" pcs.

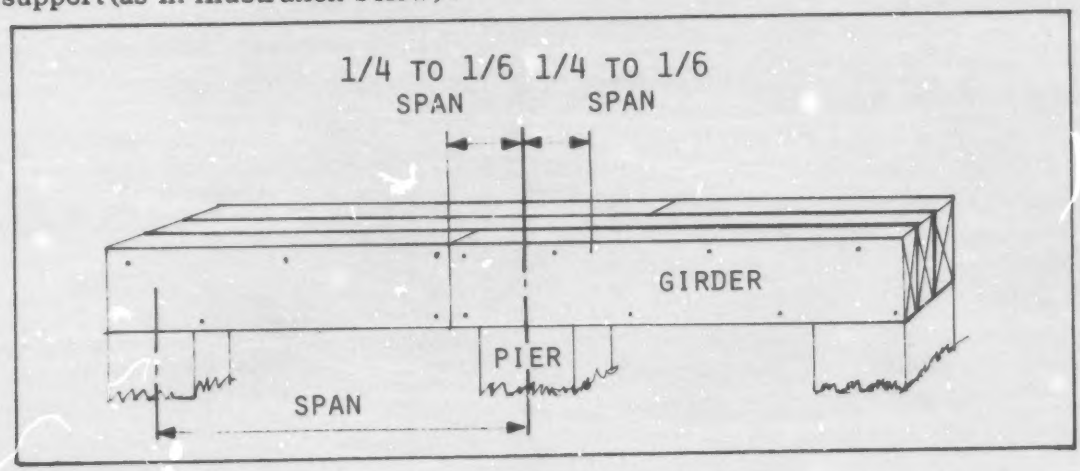
Note: The girder sizes in the chart are solid girders. If the girder is to be built-up of 2" planks, two 2" planks equal only 3", whereas a dressed 4" plank equals 3½". Therefore, built-up girders will not carry as great a load as solid girders. Use the factor at the bottom of the chart to check the load carrying capacity of built-up girder selected.

Example: 4698 lbs. x .887 (6" girder made of (3) 2" pcs.) = 4167 lbs.

In framing and installing wood girders particular attention should be paid to the architect's plans and details. Note girder type, size, and material; lengths, location of supports, method of anchoring, and corner construction. Select material type and size. Position on piers and check location of joists. Be sure the top of members are even and the crowned side is up.

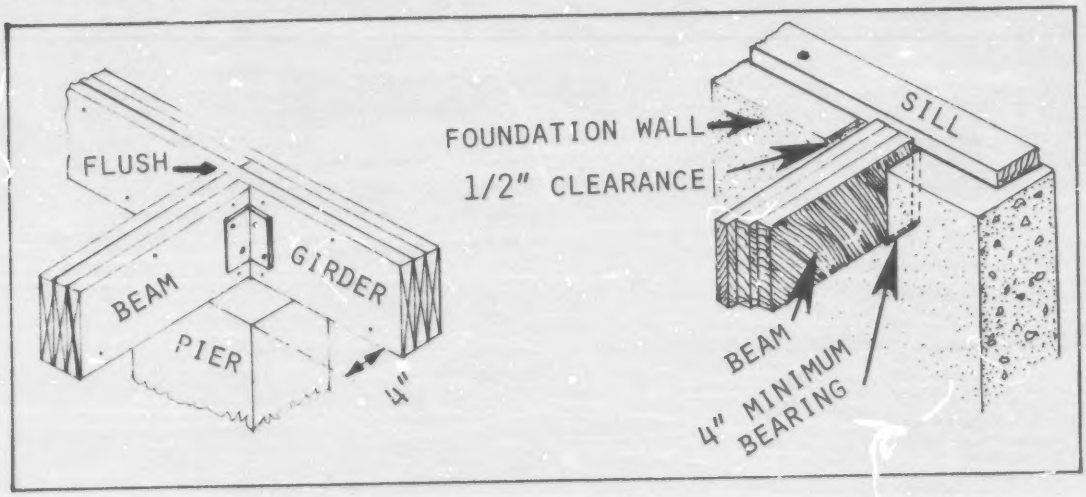


Joints in girders spanning three or more supports are ideally staggered over the supports (see illustration on previous page). However, joints may be located 1/4 to 1/6 the span length from the intermediate support, with no two adjoining members, or more than one-third the total joined members on the same side of the support (as in illustration below).



Align and nail together the members of the girder. Use 20d nails, spaced approximately 30" and staggered alternately on opposite sides of outside members.

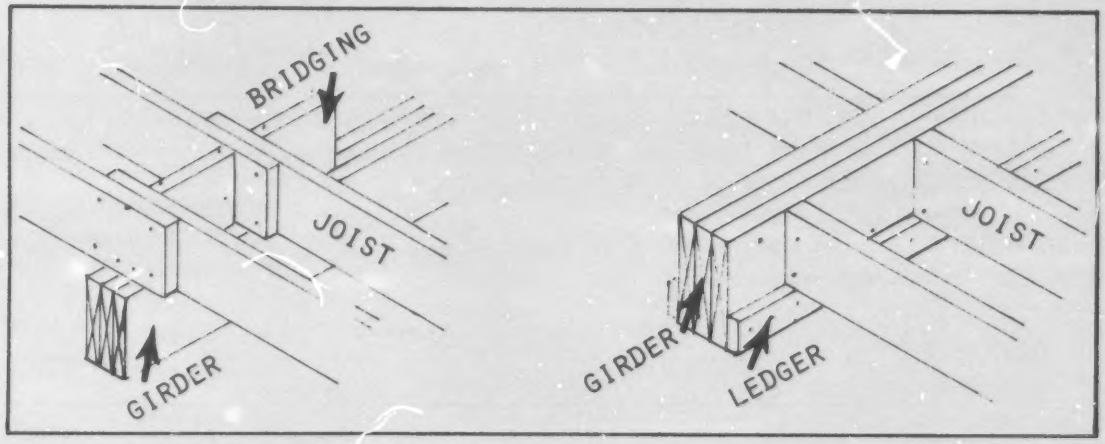
Level the girders from pier to pier and grout with portland cement. Attach to pier anchors as per details and specifications. Wood girders used as intermediate beams in sill and beam type construction should bear at least 4" on the foundation wall or pier. A ½" air space should be provided on all sides if the beam is framed into the masonry and steel bearing plates placed at each end between the bottom of the beam and the masonry.



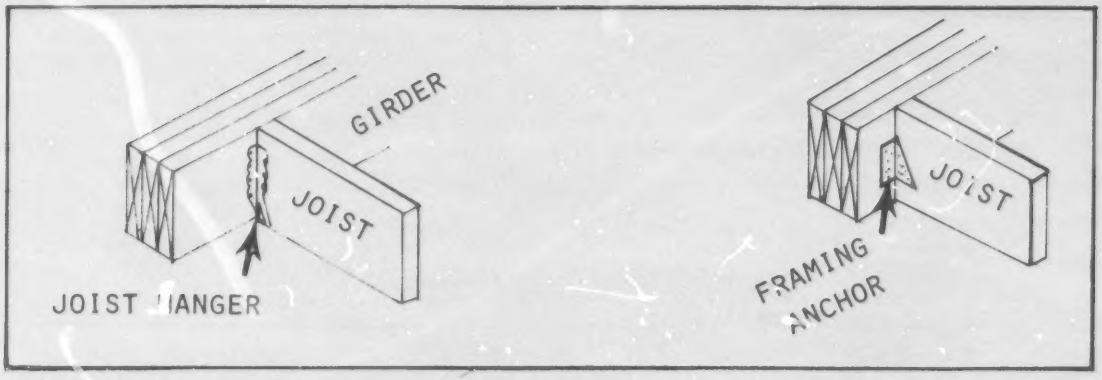
The top of the intermediate beam is normally aligned with the top of the sill on wall foundations and with the top of the girder on pier foundations.

Floor Joists

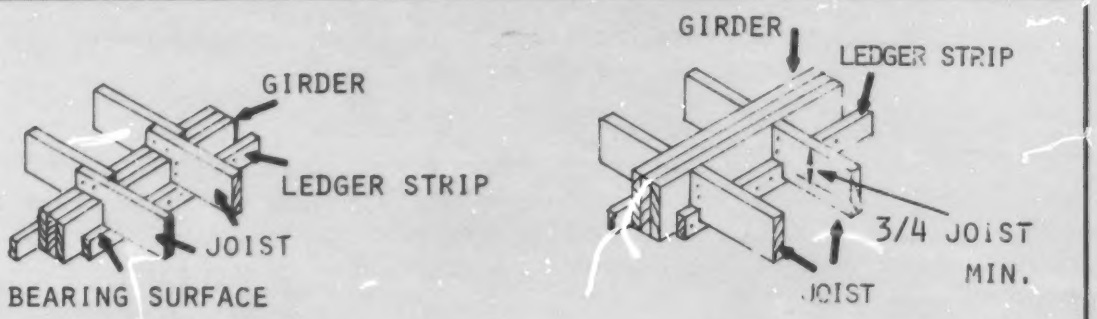
Floor joists are the framing members that carry the weight of the floor to the sills and girders. In the simplest form of floor framing, the joists rest on top of the sills and girders, lap over intermediate beams, and are enclosed at each end by sill headers. This method is used where height - crawl space and/or basement headroom clearances - is no problem.



However, wood joists may be framed into the sides of wood girders in several different ways to conserve space. One method is to rest joists upon ledger boards attached to the girders and toenail the joist ends to the side of the girder. Another method uses commercial clip angles and/or joist hangers made especially for butting joists flush with the girder.



Still another method of conserving vertical space is by a combination of installing ledger boards and notching floor joists to fit. This method is used only when absolutely necessary as it is time consuming and runs up construction costs.



NOTE: NOTCHED JOISTS BEAR ON LEDGER STRIPS
JOIST BEARING AREA MUST MAINTAIN 3/4 OF JOIST WIDTH

Floor joists generally span the narrow distance between main supports (girders) and are normally spaced on 16" centers. Always check the house plans to determine size direction, and spacing of joists. Always check the sections and details for construction. The following table may be used to determine the sizes of joists for ordinary houses where floor loads are normal, 40 lbs. per square foot uniformly distributed with a plaster ceiling, and based on the use of No. 1 Common grade lumber.

Nominal Lumber Size	Spacing on Centers	Maximum Clear Span Between Supports					
		So. Pine & Douglas Fir		Western Hemlock		Spruce	
		Unplast.	Plast.	Unplast.	Plast.	Unplast.	Plast.
2" × 6"	12"	11'-4"	10'-6	10'-10"	10'-2"	10'-4"	9'-8"
	16"	10'-4"	9'-8"	9'-10"	9'-2"	9'-4"	8'-8"
2" × 8"	12"	15'-4"	14'-4"	14'-10"	13'-10"	14'-0"	13'-0"
	16"	14'-0"	13'-0"	13'-6"	12'-6"	12'-10"	11'-10"
2" × 10"	12"	18'-4"	17'-4"	17'-10"	16'-10"	17'-0"	16'-2"
	16"	17'-0"	16'-2"	16'-6"	15'-8"	15'-10"	15'-0"
2" × 12"	12"	21'-2"	20'-0"	20'-6"	19'-4"	19'-8"	18'-8"
	16"	19'-8"	18'-8"	19'-0"	18'-0"	18'-4"	17'-4"

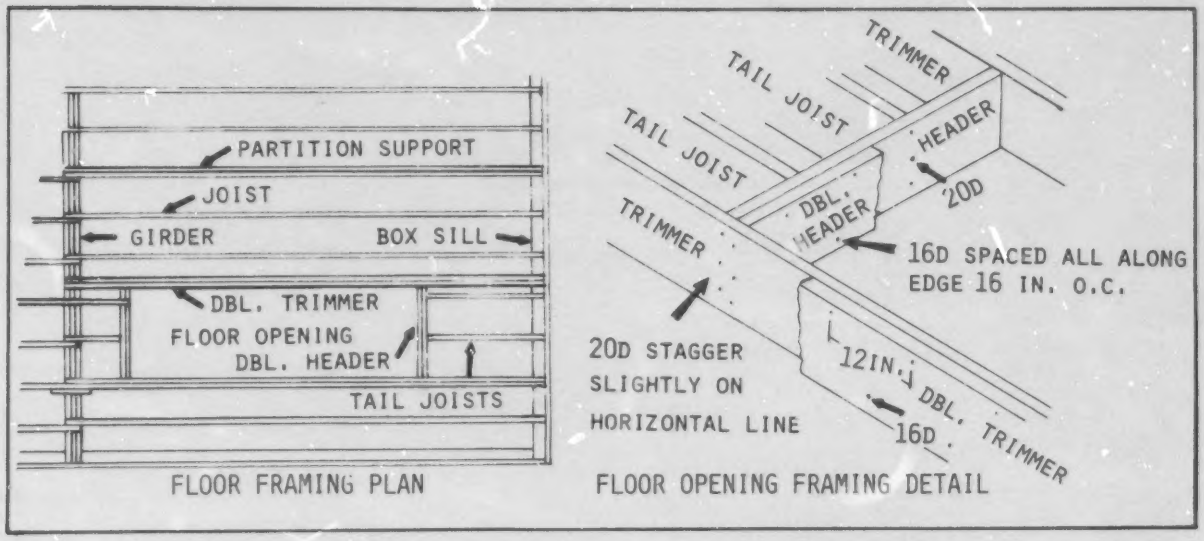
Joists are doubled under cross partitions (an interior wall which runs parallel to the floor joists) and around floor openings. Floor openings require special floor frame members such as:

Trimmers - extra joists each side of floor opening that receive headers.
Headers - short joists at right angles to trimmers that close the ends of floor openings.
Tail joists - short joists on normal spacing that run from the opening header to the main support members.

To frame floor openings, lay out and locate the trimmer joists on the sill and girder at the same time as regular joists. The location of the trimmer joists should not

interrupt the spacing of regular joists. Position the inside trimmers with their crowned edge up and securely nail to the girder and box sill.

Note: Any joist having a slight bow edgewise should be placed with the bowed edge (crown) up. The largest edge knots should be placed up, since they appear on the compression side or bow side of a joist. A crowned joist will tend to straighten out when normal floor loads are applied.

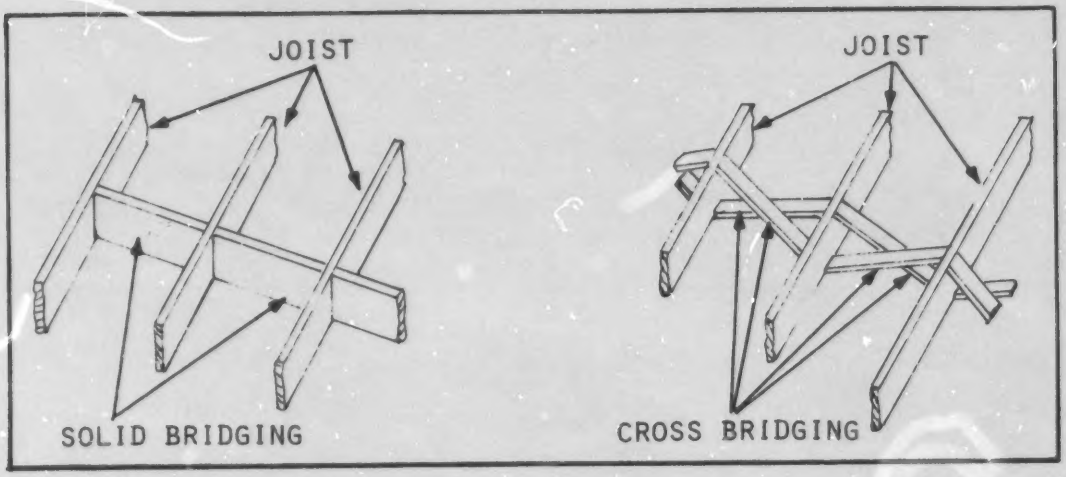


Locate the floor opening along these trimmers and mark with square lines on top of trimmers. Mark square lines 1½" and 3" outside of opening marks, each end, to locate headers. Cut headers (4) to length and square. Position outside headers one-at-a-time to the appropriate marks; square with, and flush to the trimmers. Spike through the trimmers into the headers 20d casing nails as shown in the framing detail above.

Cut tail joists to correct length and square. Position and toenail to sill or girder and spike through outside header with 20d casing nails as shown on regular joist spacing. Add the double (inside) headers as shown. Nail to the outside header and spike through the trimmer as shown. Add the double trimmer each side as shown. Remember to turn the crowns up and keep the tops flush. Slant the 16d nails slightly - about 15° - to keep the points from breaking through the floor opening.

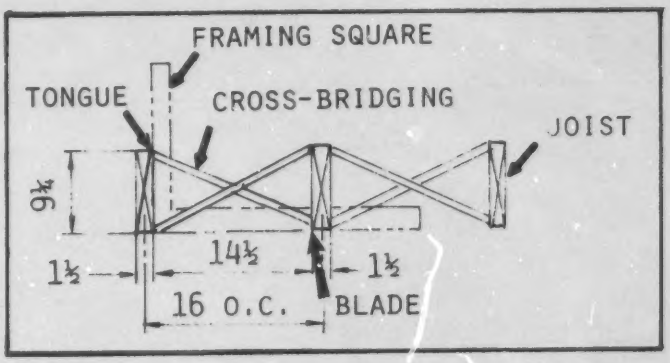
Bridging

Bridging is used when floor joists cover long spans to help stiffen the floor frame. Bridging prevents unequal deflection (bending) of the joists by offering assistance to an overloaded joist from the joists on either side of it.



There are two types of wood bridging: solid bridging and cross bridging. Cross bridging is generally used since it is very effective and requires less material; usually 1 x 3 or 1 x 4.

Lay out cross bridging using a framing square as shown below. Mark and cut the first piece and check the piece for a good fit. Use the first piece for a template to cut the other pieces.



To install cross bridging, snap a chalk line across the top, square with the floor joists at the mid point of their span. Start two 8d nails near each end of bridging on opposite side from the bevel. Start at one wall and nail one piece of bridging in place; top only. Continue placing one row on each side of chalkline, forming a cross between joists. Note: Do not nail the bottom until the subfloor has been laid. This permits floor joists to adjust themselves to their final position.

Subflooring

Subflooring serves several important functions. It tends to stiffen the floor and building frame; it provides a solid base for the finish flooring; and it acts as insulation and soundproofing. The major types of subfloors are 1 x 6 boards laid square (90°) with, or diagonally (45°) with the floor joists, and 4' x 8' plywood sheets placed square with the floor joists. It is important to remember in laying subfloor to stagger the joints and place them squarely on top of the joists. Also important is to allow the proper space between boards and/or sheets for any swelling

of the subfloor after it has been installed. Many carpenters will use an empty match folder double to space plywood sheets and a 6d nail to space wood boards. Wood boards should be face nailed at every joist with two 8d nails while plywood should be nailed along every joist with 8d nails spaced approximately 10" apart.

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

III-B-1(S)

TASK:	Install Floor Joists - Platform Floor Framing
AIM:	The student(s) will be able to properly lay out and install floor joists on top of sills and beam.
TOOLS AND EQUIPMENT:	25' steel tape measure, framing square, cross-cut saw (hand or portable power), claw hammer
MATERIALS:	Framing lumber as per specifications: 10,16,20d common nails as required
TEACHING AIDS:	III-B-1 Job and task sheets, blueprints and specifications
REFERENCES:	Wagner, William H., Modern Carpentry, Unit 7
PREREQUISITE EXPERIENCE OF THE LEARNER:	The student(s) must have successfully completed all previous lessons in Major Block III and continue to show a sincere interest in learning the building trades.
CHECKING STANDARDS:	1. Material selection 2. Joist layout 3. Joist placement 4. Framing floor opening

I. PREPARATION (OF THE LEARNER - MOTIVATION)

Poorly designed and installed floor joists are the most probable cause for failure in frame construction. They will cause floors to squeak, partitions to sag, doors to stick, and plaster to crack.

Properly designed and installed floor joists support the loads of the room they span. They also act as ties between exterior walls and interior partitions and tend to stiffen the frame of the building.

Properly placed joists should lie uniformly spaced and square to the sills and girder bearing at least 4" on each. They should be fastened to the sill and girder by toenailing and spiked through the sill header each end. The joists should be uniformly framed so their tops form a straight and level floor line.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. Check Plans, Specifications	1. Study house plans, floor plans, specifications a. Determine type of material b. Determine size of joists c. Determine direction of joists d. Determine spacing of joists 2. Note location of partition wall, types of partitions 3. Note location, size of floor openings

2. Lay Out and Mark Trimmer Joists for Floor Openings

1. On sill or header and girder between which openings occur
2. Use steel tape measure and framing square
3. Measure accurately, dimensions indicated on framing plan:
   a. From end of building to floor opening
   b. Width of floor opening
4. Mark lines square each side of opening
5. Mark lines square outside of opening
   a. Two lines each side
   b. Spaced 1½" apart
6. Mark "T" for trimmer in spaces between lines

3. Lay Out and Mark for Double Joists Under Partion Walls

1. On sill or header and girder between which partition wall occurs
2. Use steel tape measure and framing square
3. Measure accurately
   a. Dimension indicated on floor plan and/or framing plan
   b. From end of building to center of partition wall
4. Mark line square on sill or header and girder

Note: For spaced double joist

5. Mark line on each side of centerline (key point #4) above
   a. 3½" from centerline each side
   b. Parallel to centerline, each side
   c. Mark "X" inside each line toward centerline

Note: For standard double joist

6. Mark line each side of centerline (key point #4) above
   a. 1½" from centerline, each side
   b. Parallel to centerline, each side
   c. Mark "X" between lines in spaces

4. Lay Out and Mark Regular Joist Spacing

1. On sill or sill header
2. Use framing square and pencil
3. Position framing square
   a. Start at one end of header
   b. With inside of blade along top edge of header
   c. With tongue lying across top of header
4. Mark lines each side of tongue square across top of header
5. Mark "X" between lines for joists
6. Mark "XT" between lines for tail joists - joists which fall within floor openings
7. Slide framing square along top of header

8. Align 16" dimension inside blade with first marked line approached
9. Repeat key points #4, #5, #6, #7 until all joists are laid out

Note: If joists are lapped over a central girder or beam, set first dimension inside blade of framing square on 16 3/4" on the opposite side sill or header to allow for the lap over central girder

5. Install Header Joists

1. Select material size and quality as per plans and specifications
   a. Use full 14'-16' lengths where possible
   b. Straight with little or no warpage
2. Measure and cut joists to length square
3. Place joists in position one-at-a-time
   a. With the crown turned up
   b. With the end butted square and flush to the sill header
   c. With the edge flush and plumb along outside of sill

Note: Header joists are butted flush and connected with a splice plate on the inside at the center

4. Nail joists in place
   a. Toenail to sill along outside to stand plumb and erect
   b. Use 10d nails space 16" O.C.
   c. Spike ends through header
   d. Use (2-3) 20d nails as required

6. Install Regular Joists

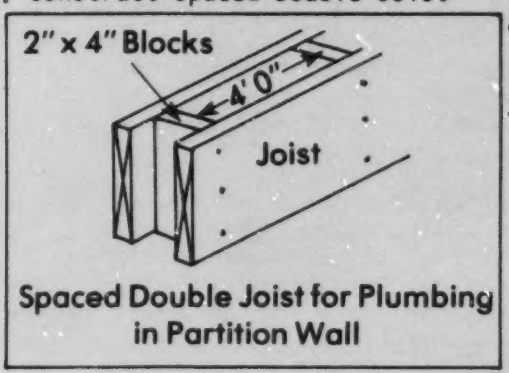
1. Select material as in step #5
2. Position material
   a. With crowns up
   b. On marks with "X"
   c. Square with sill and flush with header
3. Secure joists one-at-a-time
   a. With (3) 10d nails toenailed to sill
   b. With (2) 20d nails spiked thru header
   c. With centers lapped and nailed together, then toenailed to beam

7. Construct Double Joist

1. Select material as in step #5
2. Position material together
   a. On flat nailing surface
   b. Flat, with crowned edges together
   c. Ends flush
3. Nail double joists together tightly
   a. Start at one end (6" from)
   b. Use 16d nails spaced approximately 16"
   c. Nail crowned edges first, pulling crowned edges together flush

d. Nail bottom edgee second, alternately spacing nails with top
e. Clinch protruding nails

8. Construct Spaced Double Joist



Spaced Double Joist for Plumbing in Partition Wall

1. Select and position material as in step #1
2. Cut 2 x 4 spacer blocks
   a. To length of joist width
   b. Square
3. Position spacer block
   a. Width between joists
   b. Square and normal to joists
   c. 6" from each end
   d. Spaced approximately 4'-0

9. Install Double Joists

1. Similar as regular joists step #6
2. Position double joists
   a. With crown up
   b. On marks locating double joists
   c. Square with sill and/or girder
   d. Butted flush to header
3. Secure double joists
   a. With 10d nails
      1.) Toenail to sill and/or girder
      2.) (2) each side, each end
   b. With 20d nails
      1.) Spike thru header
      2.) (2) nails each joist
      3.) Stagger nails slightly in header

10. Frame Floor Openings

1. Lay out location and width of opening
   a. On sill and girder
   b. As per step #2 this lesson
2. Place and secure inside trimmers
   a. To lines marked
   b. Toenail inside of trimmers
   c. Spike ends thru header
3. Mark location and length of opening
   a. On both trimmers
   b. With lines square to trimmers
4. Mark location for double headers
   a. Outside of opening marks on trimmers
   b. Spaced 1½" and 3" each end
5. Cut headers to length
   a. Length taken at sill between trimmers
   b. Pieces (4), cut to length square
6. Position single headers
   a. On outside marks on trimmers
   b. Square between trimmers
   c. With tops flush to joists

7. Spike single headers between joists
   a. While holding in place
   b. Use (3) 20d spikes for 2 x 8 joists
   c. Use (4) 20d spikes for 2 x 10 joists
8. Measure and cut tail joists to length, square
9. Mark tail joists (regular spacing) on header joists
10. Spike tail joists to headers at these points
11. Spike double headers to single headers using 16d nails
12. Spike ends of double headers thru trimmer joists

Note: Stagger nail pattern slightly from single headers

13. Spike double trimmers to single trimmers holding tops flush
    a. Use 16d nails
    b. Staggered approximately 16"
14. Spike double trimmers thru sill header
15. Toenail double trimmers to sill; girder

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

Instructor: Demonstrate joist layout double joist construction

Instructor: Emphasize framing floor openings, nail sizes and patterns

Instructor: Pass out job sheet, task sheets

Students: Practice jobs, tasks

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY

Performance Test!

Students install floor joists as per blueprints and specifications

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

Poorly designed and installed floor joists are the most probable cause of failure in frame construction. They will cause floors to squeak, partitions to sag, doors to stick, and plaster to crack.

Floor joists are horizontal frame members laid edgewise in series to support the floors of the room they span. Floor joists also act as a tie between walls and tend to stiffen the building frame.

Certain rules should always be observed when installing floor joists:

1. Select the best material specifications allow as there is wide variation within a lumber grade. Select straightest lumber with fewest knots.

2. Always turn crowned edge up when placing joists. A crowned joist will tend to straighten out when normal floor loads are applied. Largest edge knots indicate crowned edges as they are on the compression side of the member.
3. Double joists under wall partitions and around large floor openings.
4. Measure and cut all joists to length, square.
5. Use appropriate nail sizes and patterns when doubling joists or framing openings. Keep top edges flush!
6. Toenail singl joists with (3) 10d nails at sill; at girder.
7. Toenail double joists with (4) 10d nails at sill; at girder.
8. Spike joist ends to sill header using 20d nails.
9. Spike lapped joists over girder together using 16d nails.

SUGGESTED READING FOR THE STUDENT:

Modern Carpentry, Unit 7, pp. 121-126

THE NEXT LESSON IS: III-B-2(S), Installing Floor Bridging

JOB SHEET
IN
FLOOR FRAMING

III-B-1(J)

NAME OF JOB:	Install Floor Joists
DRAWINGS:	Architectural floor plans, framing plans, and details
MATERIALS:	Framing lumber as per specifications 10d, 16d, 20d common nails as required
TOOLS AND EQUIPMENT:	25' steel tape rule, framing square, pencil, cross-cut saw (hand or portable power), claw hammer
GENERAL INSTRUCTIONS:	Study the plans and specifications. Determine the joists' size spacing, and direction. Note special details such as method of framing into girders and sills; location and types of double joists; location and size of floor openings. Proceed as follows:
PROCEDURE AND/OR TASKS:	III-B-1(TS) Lay Out and Mark Joists on Sills and Girder III-B-1a(TS) Construct Double Joist III-B-1b(TS) Construct Spaced Double Joist III-B-1c(TS) Frame Floor Opening III-B-1d(TS) Install Regular and Double Joists

TASK SHEET III-B-1(TS)

TASK: Lay Out And Mark Joists On Sills Or Headers And Girder(s)

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape rule, framing square, pencil

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Lay Out and Mark Trimmer Joists for Floor Openings	1. Along sill or header, and girder between wich openings occur 2. Use steel tape and framing square 3. Measure accurately: a. Dimensions indicated on framing plan b. From end of building to floor opening c. Width of floor opening 4. Mark lines square each side of opening 5. Mark lines square outside of opening a. Two lines each side b. Spaced 1½" apart 6. Mark "T" for trimmer in spaces between lines
2. Lay Out and Mark Double Joists Under Wall Partitions	1. Along sill or header, and girder between which partition walls appear 2. Use steel tape and framing square 3. Measure accurately: a. Dimension indicated on framing plan b. From end of building to centerline of wall 4. Mark line square on sill and girder (denotes centerline) 5. Mark lines square each side of centerline a. 1½" each side for regular double joist b. 3½" each side for spaced double joist 6. Mark "x"s inside each line toward centerline for double joists
3. Lay Out and Mark Regular Joists	1. Along sill or header, and girder 2. As per framing plans 3. Position framing square a. At end of sill or header; also building line b. With inside of blade along top edge of sill or header c. With tongue lying across top of sill or header d. With 15¼" dimension inside tongue aligned with end of sill or header

STEPS	KEY POINTS
	4. Mark lines each side of tongue, square across sill or header 5. Mark "X" for joist between lines 6. Slide framing square along top of sill or header 7. Align 16" dimension inside blade with first previously marked line approached 8. Repeat key points #4 and #5 Note: If lines fall between marks locating floor openings "T", mark with "XT" for tail joists 9. Continue key points #6, #7, #8 until all regular joists are located Note: If joists are lapped over a girder or beam, set first dimension inside blade of framing square on 16 3/4" on opposite side sill or header to allow for the lap over the girder
Check Point:	Double check joist layout 1. Location of floor openings, wall partitions 2. Spacing of regular joists

TASK: Construct Double Joist

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape, framing square, pencil cross-cut saw, claw hammer. As per plans and specifications: framing lumber, 16d common nails

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Select Material	1. Size and grade according to plans and specifications 2. Best within grade specification a. Least knots b. Straightest; least warpage 3. Lengths adequate
2. Cut Material To Length	1. As necessary 2. Square one end 3. Lay out length using steel tape rule 4. Cut material to length square
3. Position Material	1. On flat nailing surface 2. Stacked one on top of the other 3. With crowned edges together 4. With ends flush
4. Nail Double Joist Together	1. Use 16d common nails 2. Start at one end; ends flush 3. Nail crowned edges tightly a. Spacing nails approximately 16" b. Pulling crowned edges flush 4. Nail bottom edge tightly a. Spacing nails alternately b. Clinch all protruding nails
Check Point:	Check: Tight construction Crowns flush Overall length Ends square

TASK: Construct Spaced Double Joist

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape, framing square, pencil, cross-cut saw, claw hammer
As per plans and specifications: framing lumber, 16d common nails

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Select Material	1. Size and grade according to plans and specifications 2. Best within grade specification a. Least knots b. Straightest; least warpage
2. Cut Material To Length	1. As necessary 2. Lay out lengths using steel tape a. Joists as per plan dimensions b. 2 x 4 spacer length of joists width 3. Mark and cut to length square
3. Position Material	1. Flat - on sound nailing surface 2. Joists stacked one on top of the other a. With crowned edges together b. With ends flush 3. Place spacer blocks between joists a. On edge (3½" space) b. With length of spacer set to width of joists c. 6" from ends on approximately 3'- 0 intervals
4. Nail Joists To Spacer Block	1. While holding in place 2. Use 16d common nails a. (3)each side on 8" joists b. (4) each side on 10"-12" joists 3. Nail one side at-a-time a. Start at one end b. Spike thru joist into spacer c. Spikes centered with spacer 4. Pull crowned edges flush to common plane when nailing second joist
Check Point:	Check construction: crowns flush ends square and flush tight construction overall length

TASK SHEET III-B-1c(TS)

TASK: Frame Floor Opening

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape rule, framing square, pencil, cross-cut saw, claw hammer, as per plans and specification: framing lumber, 10,16,20d common nails

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Lay Out Location and Width of Opening	1. On sill or header, and girder between which opening occurs 2. Use steel tape and framing square 3. Measure accurately, dimensions shown on framing plan a. From end of building to floor opening b. Width of floor opening 4. Mark lines square each side of opening 5. Mark lines square outside of opening a. Two lines each side b. Spaced 1½" apart 6. Mark "T" for trimmer in each space
2. Install Single Trimmer Joists	1. Select joist material as in previous tasks III-B-2a and 2b(TS), step #1 2. Cut material to length as in previous tasks III-B-2a and 2b(TS), step #2 3. Position inside trimmer joists a. On edge with crowns up b. To appropriate marks on sill or header and girder c. Square and flush to sill header 4. Secure inside of trimmer joists a. Toenail to sill and girder with (2) 10d nails each end b. Spike end to sill header with (3) 20d nails
3. Lay Out Location and Length of Opening	1. On trimmer joists 2. Use steel tape and framing square 3. Measure accurately, dimensions shown on framing plan a. From building line to floor opening b. Length of floor opening 4. Mark lines square each end of opening a. On top and inside edge b. Of each trimmer joist 5. Mark lines for headers a. Outside of ends of opening b. Two lines, each end, each trimmer

STEPS	KEY POINTS
	c. Spaced 1½" apart d. On top and inside edge of trimmers
4. Install Single Headers	1. Same size and grade as trimmer joists 2. Cut to length square a. Length taken between trimmers b. At the sill or girder Note: Cut all four headers at this time 3. Position single headers a. Each end of opening, one-at-a-time b. Between trimmer joists c. With crowned edge up d. To outermost marks locating headers e. With top butted flush to trimmers 4. Spike ends of header thru trimmers a. Use (3) 20d nails each end, for 8" joists b. Use (4) 20d nails each end for 10" joists
5. Lay Out Tail Joists	1. On top, outside edge of headers a. Take dimensions from sill and girder b. Between trimmer joists 2. Measure accurately 3. Mark lines square on top; outside
6. Install Tail Joists	1. Select joist materials as previous tasks 2. Cut tail joists to length square a. From sill header to opening header b. From opening head (opposite side) to far side of beam or girder 3. Position tail joists one-at-a-time a. On edge with crown up b. Between sill header and opening header, or c. From opening header to top of girder d. To marks on header, sill, or girder e. With tops flush to headers 4. Secure tail joists one-at-a-time a. While holding in place b. Toenail (3) 10d nails to sill or girder c. Spike (3) 20d nails to end thru headers
7. Install Double Headers	1. Position double headers (pre-cut) a. With crowns up b. Flush against inside of single header c. With top flush 2. Face nail to single header a. Use 16d common nails b. Spaced 16" along each edge c. Stagger spacing 3. Spike ends of header thru trimmers

STEPS	KEY POINTS
	a. Use 20d common nails b. Stagger spacing slightly from that of single header
8. Install Double Trimmers	1. Select and cut material to length as in step #2 this task 2. Position double trimmers a. With crowns up b. Outside and butted flush against single trimmers 3. Nail to single trimmer Note: Use same procedure and nail pattern as constructing double joists 4. Toenail double trimmer to sill and girder a. On outside b. Use (2) 10d nails each end

TASK: Install Regular And Double Joists

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape, framing square, pencil, cross-cut saw, claw hammer, framing lumber, 10d, 20d, common nails

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Install Regular Joists	1. Select joist material and cut to length as per previous task III-B-2a(TS) 2. Position joist a. With crown up b. To appropriate marks on sill or header and girder 3. Toenail with (3) 10d nails each a. To sill b. To girder 4. Spike ends with 20d nails a. (3) nails in 8" joist b. (4) nails in 10" joist c. Spike thru header
2. Install Double Joists	1. Pre-fabricate as per task sheets III-B-2a(TS) or III-B-2b(TS) 2. Position double joists a. With crowns up b. To appropriate marks on sill or header and girder 3. Toenial with (2) 10d nails a. Each side b. In sill; in girder 4. Spike ends with 20d nails a. Each joist b. Same as regular joist Note: Stagger nail pattern of joists slightly

INSTRUCTOR'S PLAN
INFORMATIONAL LESSON

III-B-2(I)

SUBJECT: Types of Floor Frames, Floor Frame Components

AIM: The student(s) will be able to identify major types of floor framing and framing components. The student will further be able to follow established building practices and procedures to construct floor frames in accordance with specified plans and details.

TEACHING AIDS: Architectural prints and specifications, overhead projector, Transparencies I. ED. IV-18T, Part II, chalkboard, Information Sheet III-B-2(IS)

MATERIALS:

REFERENCES: Wagner, Willis H., Modern Carpentry, The Goodheart-Willcox Co., Inc., South Holland, Illinois
Jones R.P., and Ball, J.E., Framing, Sheathing And Insulation, Delmar Publishers, Albany, New York
Feirer, John L., and Hutchings, G.R., Guide To Residential Construction, Bennett Publishing Company, Peoria, Illinois

PREREQUISITE EXPERIENCE OF THE LEARNER: Successful completion of Major Block II, "Foundations"
Successful completion of previous lesson III-B-1(I), "Types of House Framing, Framing Components"

I. PREPARATION (OF THE LEARNER - MOTIVATION)

Floor framing consists of sills, headers, girders and/or beams, joists, bridging, and sub-flooring. All members are tied in such a way as to support the load on the floor and the load bearing walls of the building itself. The method, or type, of floor frame depends on the type of foundation and house frame selected by the architect. As there are different types of foundations, so are there different types of house frames and, consequently, different types of floor framing.

The building trades student must be able to read architectural prints, identify the type of construction, and develop the floor frame in accordance to the architect's plans and details. To do this, the student must be aware of the different types of floor framing and floor framing members, and possess a working knowledge of their construction processes and procedures.

II. PRESENTATION (OF THE INFORMATION)

INSTRUCTIONAL TOPICS TEACHING POINTS	THINGS FOR STUDENTS TO DO THINGS FOR INSTRUCTOR TO DO OR SAY
A. Types of Floor Frames	1. Same as types of house framing 2. Two major types a. Balloon framing b. Platform framing
Show Transparencies Figs. 59, 60	3. Outstanding features (review; point-out) a. Balloon framing 1.) Studs continuous from sill to rafter plate

2.) Upper floor joists rest on ribbon let-in to wall studs
3.) Floor joists (all) spiked to studs to support and tie structure

b. Platform framing
1.) Floor frame built as a platform, each level
2.) Platforms are built to building lines
3.) Platform provides base on which to build wall sections one story high

B. Parts of Floor Frame

Note: Parts will vary in size and design depending on type foundation, imposed loads, spans, spacing, vertical clearances

1. Sills and Headers

1. Description
a. First framing member set in place
b. Flat, horizontal member sits directly on foundation wall
c. Held in place by anchor bolts mounted in foundation
d. Outside edge generally set to building lines
2. Purpose - provides a base for fastening the rest of the wood frame to the foundation
3. Types
a. Single sill (ends butted)
b. Double sill (ends lapped)
c. "T" sill
1.) Used in balloon framing
2.) Header centered on sill plate
3.) Header may be cut and placed between joists
d. "L" sill - also called box sill
1.) Used in platform framing
2.) Header mounted flush with outside of sill
3.) Frames in joists for platform decking

2. Girders/Beams

1. Description
a. Large horizontal support members
b. Used with pier type foundation
c. Strong enough to span from pier-to-pier and support building loads

Note: Girders replace sills in pier foundation. Beams are intermediate supports when building width too great for joists to span

2. Purposes and function
a. Supports outside bearing walls/building

loads
b. Supports floor joists/floor loads
c. Provides a base for fastening wood frame to foundation

3. Types
a. Solid
b. Built-up
c. Laminated
d. Structural steel

3. Floor Joists

1. Description
a. Horizontal support members
b. Set on edge on top of sills/girders
c. Generally spaced 16" O.C.
d. Span room-building widths

2. Purpose and function
a. Support loads of floor they span
b. Act as a tie between walls
c. Tend to stiffen building frame

3. Types and connections
a. Butted flush with girders
b. Lapped on top of girders
c. Notched to sit on ledgers
d. Doubled under wall partitions
e. Trimmer joists/header for floor openings

4. Bridging

1. Purpose and function
a. Acts as reinforcement and stiffener for joists
b. Serves to distribute concentrated loads
c. Adds strength to the floor unit

2. Types
a. Wood cross bridging
b. Metal cross bridging
c. Solid bridging (wood)

5. Firestops/Nailers

Note: Used in balloon framing only

1. Purpose and function
a. Prevent up-drafts of air in wall frame between floors
b. May be used to nail sub-floor

2. Description
a. Horizontal block fit between wall studs, or wall stud and adjacent floor joist
b. Top of block generally flush with top of header
c. Material size same as wall studs

6. Sub-Floor

1. Purpose and function
a. Acts to brace floor joists; building frame
b. Provides a platform during construction

c. Provides substantial base for finish flooring
d. Adds to insulation; soundproofing

2. Types/description
   a. Plywood/particle board
      1.) 4' x 8' panels; joints staggered
      2.) 5/8", 3/4", 7/8" thickness depending on joist spacing
   b. Wood board
      1.) 1" thickness, up to 8" widths nominal
      2.) May be installed square with, or diagonally (45°) to joists
      3.) Joints staggered on joists

III. APPLICATION (DRILL, ILLUSTRATIONS, ANALOGIES, ORAL QUESTIONS, OR ASSIGNMENTS, MAKING INVESTIGATIONS OR EXPERIMENTS, NOTE TAKING, MAKING SKETCHES, PARTICIPATING IN DISCUSSION.)

Field Trip! Major Housing/Apartment development in framing stage
Note: Combine trip with field trip, lesson III-B-1(I)

Special Assignments:

Model Floor Frame - use pier foundation; girders, beams, joists flush construction using joist hangers, clip angles; wood cross bridging, wood board sub-floor installled diagonally.

Model Floor Frame - wall type foundation; use sill and beam flush construction; joists lapped on top of beam; solid bridging; plywood sub-floor.

Drill: Identify parts of floor frame.
Explain purpose and function of each part.

IV. VERIFICATION AND/OR EVALUATION (FINAL CHECK ON STUDENT'S COMPREHENSION OF MATERIALS PRESENTED.)

True-False:

1. A platform type floor frame is constructed on wall type foundations only. F
2. Balloon framing necessitates solid bridging. F
3. "T" sills are used in conjunction with balloon framing. T
4. Platform floor frames are generally built to the building lines. T
5. Floor frame parts vary in size depending on loads, spans, spacing, and clearances. T
6. Upper floor joists rest on ribbons in platform framing. F
7. The first wood frame member set in place of a wall type foundation is the header. F

8.	Another name for the "L" sill is box sill.	T
9.	Headers may be cut and placed between joists in platform framing.	F
10.	Floor joists are generally spaced on 24" centers.	F
11.	Bridging adds strength to the floor unit.	T
12.	Firestops prevent air drafts in platform framing.	F
13.	Firestops may be used as nails for sub-floors.	T
14.	One function of the sub-floor is to aid soundproofing and insulation.	T
15.	Platform framing is the most popular form of modern home construction.	T

V. SUMMARY (GIVE A BRIEF ACCOUNT OF EACH TOPIC REEMPHASIZING THE IMPORTANT POINTS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENT.)

The two major types of house framing are "Balloon" framing and "Platform" framing. The method in which a house is framed also indicates the method or type floor frame.

Floor framing consists of sills, headers, girders and/or beams, joists, bridging, and sub-flooring all tied together in such a way to support the load on the floor and load bearing walls of the building itself.

The sill is the first framing member set in place on wall type foundations. It is a flat, horizontal member generally set to building lines and held in place by anchor bolts in the foundation. The sill provides a base for fastening the rest of the frame to the foundation. There are several types of sill, some of which incorporate sill headers in the construction. The header is a horizontal member turned on edge to enclose the floor frame. In balloon framing, a "T" sill places the header centered on the sill flush with the inside of the studs, while in platform framing the "L" sill places the header flush with the outside of the sill.

The girder replaces the sill on a pier type foundation. The girder is a strong, horizontal support member which spans from pier-to-pier and supports the loads imposed by the floors and bearing walls. Beams are intermediate supports similar to girders employed when building widths are too great for joists to span.

Floor joists are horizontal members, placed on edge in a series to support the floor loads they span. Floor joists also act as ties between exterior wall and interior partitions and tend to stiffen the building frame. They may be mounted flush with girders and beams using joist hangers and clip angles; notched to set on ledgers or beams; or butted or lapped on the tops of sills, girders, and beams depending on the architect's design details and vertical clearances.

Bridging reinforces floor joists and acts/aids to distribute loads over several joists. The major types of bridging are cross-bridging (wood), cross-bridging (metal), and solid bridging (wood).

Firestops are necessary in balloon framing to prevent air drafts in the wall frame; a safety feature to prevent rapid spread of fires and aids in insulation. Properly placed firestops can also act as nailers for sub-floors.

Sub-flooring completes the floor frame. In platform framing, it provides a safe working surface during wall framing; braces joists, floor, building frame; serves as a base for finish flooring; and aids in insulating and soundproofing. Sub-floors today are generally made of plywood or particle board panels, although wood boards laid diagonally (45°) or square (90°) with joists are acceptable.

Framing floor openings require the doubling of joists on either side of the opening. These joists are referred to as trimmer joists and are placed as necessary regardless of regular joist spacing. Regular joists which would pass through the opening are replaced with stud joists, called tail joists, either side (end) of the opening, allowing sufficient room for the opening to be closed in with cross members called headers. Headers are the same size as the joists and are positioned square and flush with; and nailed to the trimmers and tail joists.

SUGGESTED READING FOR STUDENTS:

Modern Carpentry, Unit 7
Fundamentals of Carpentry, Chapter 4

THE NEXT LESSON IS: III-C-1(I), Wood Sills

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

III-B-2(S)

TASK:	Install Bridging
AIM:	The student(s) will be able to cut and properly install wood cross bridging and/or solid bridging.
TOOLS AND EQUIPMENT:	Chalkline, framing square, cross-cut saw (hand or power), 25' steel tape, claw hammer
MATERIALS:	Framing lumber as per specifications, 6d common nails, 16d common nails
TEACHING AIDS:	Job sheet III-B-2(J), task sheets III-B-2(TS), III-B-2a(TS), Builder's blueprints and specifications
REFERENCES:	Wagner, Willis H., Modern Carpentry
PREREQUISITE EXPERIENCE OF THE LEARNER:	The student(s) must have successfully completed all previous lessons in Major Block III. The student(s) must continue to display a sincere interest in learning the building trades.
CHECKING STANDARDS:	1. Location of bridging (chalkline) 2. Size and fit of cross bridging first piece (pattern) 3. Bridging (installed) not above/below joist lines

I. PREPARATION (OF THE LEARNER - MOTIVATION)

Bridging is used when floor joists cover long spans. Bridging is placed between floor joists to help stiffen the floor frame. Bridging prevents unequal deflection (bending) of the joists by offering assistance to an overloaded joist from the joists on either side of it. There are two types of wood bridging: cross bridging and solid bridging. Cross bridging is generally preferred since it is very effective and requires less material.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. Acquire Bridging Space Measurements	1. Measure actual distance between joists 2. Measure actual height of the joists Example: 2 x 10 joists 16" O.C. should measure: a. 14½" between joists b. 9¼" high
2. Lay Out Wood Cross Bridging	1. Position bridging stock on edge 2. Position framing square flat on edge of stock a. With 9¼" dimension on outside of tongue to bottom edge of stock b. With 14½" dimension outside of blade to top edge of stock 3. Mark line outside of tongue across edge of stock 4. Mark point of 14½" dimension at edge of stock

Option #1

5. Slide square along edge of stock in direction of marked point
   a. Until outside of tongue is aligned with marked point
   b. Maintain 9¼" and 14½" dimensions on respective edges of stock or . . .

Option #2

5. Revolve framing square 180°
   a. Place 9¼" dimension outside of tongue on marked point at top edge of stock
   b. Place 14½" dimension to marked line at bottom edge of stock
6. Mark line outside of tongue across edge of stock

3. Cut Bridging To Length

1. Mark lines square across face of stock
   a. At points on same edge
   b. At each end of marked bevels
2. Cut bridging square
   a. To lines
   b. To bevels

4. Check Bridging For Size

1. Position bridging between joists
   a. With beveled ends vertical
   b. One end to top of joist
   c. Opposite to bottom of adjacent joist
2. Check length and bevel

Note: If bridging extends above or below joist line, shorten length 1/8" to correct and recheck.
Use as pattern to cut all bridging

5. Install Cross Bridging (Wood)

1. Start two 6d nails
   a. Each end of each piece
   b. Approximately ½" from end and edges
   c. On side opposite of levels
2. Determine location of bridging
   a. Snap a chalkline to mark locations
   b. Across the tops of the joist
3. Position and nail first bridge
   a. Between joists
   b. With one side to chalkline
   c. With a beveled end flush to the side and top of a joist
   d. Spike nails into joist at the top only
4. Position and nail second bridge
   a. In next opening
   b. With the top to the same joist
   c. On same side of chalkline
5. Nail rest of bridging in place
   a. At the tops only
   b. Continue zigzag pattern (tops-to-tops, bottoms-to-bottoms)

c. Reverse the pattern on the opposite side of the chalkline to form cross bridging

Note: Do not nail the bottom of the bridging until the joists are ready to be enclosed

6. Install Solid Bridging

1. Determine location of bridging
   a. As per framing plans
   b. Snap chalkline to mark location
   c. On tops of joists
2. Cut one-half of bridging to size
   a. Use same size material as joists
   b. Cut square to length
   c. Space between joists
3. Position first piece of bridging
   a. Between two joists
   b. Top flush with tops of joists
   c. One side to chalkline
4. Nail bridge in place
   a. Use (3) 16d nails each end
   b. Nail thru joists
5. Fasten previously cut pieces
   a. In a like manner
   b. In every other joist space
6. Cut remaining bridging 1/16" longer
7. Install remaining pieces
   a. In remaining spaces
   b. In a like manner
   c. On opposite side of chalkline

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

Instructor: Demonstrate skills as lesson is taught

Passout: Job and task sheets III-B-2(J), III-B-2(TS), III-B-2a(TS)

Students: Practice job and tasks under close supervision of the instructor

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

Performance Test!

Students install bridging according to prints and specifications

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

Bridging prevents unequal deflection (bending) of joists covering longer spans by offering assistance to an overloaded joist by tying it to joists on either side of it. Bridging also helps to stiffen the overall floor frame.

There are two types of wood bridging: cross bridging and solid bridging. Cross bridging is generally preferred as it is very effective and requires less material.

Bridging should be spaced across joists a maximum of 8'-0 to be effective.
Examples: Joists spanning 14'-0 should have one row of bridging spaced 7'-0.
Joists spanning 20'-0 should have two rows of bridging spaced 6'-8".

Cross bridging is composed of 1 x 3s or 1 x 4s criss-crossed between joists and nailed to the sides near the top and bottom edges of joists.

Solid bridging is composed of short pieces of joist material fitted between joists, staggered each side of a line and end nailed through the joists.

Care should be exercised not to allow bridging to extend above or below the joist lines.

SUGGESTED READING FOR STUDENTS:

Modern Carpentry, Unit 7

THE NEXT LESSON IS: III-C-1(S), Install Wood Plank Subfloor

JOB SHEET
IN
PLATFORM FLOOR FRAMING

III-B-2(J)

NAME OF JOB:	Install Bridging
DRAWINGS:	Builder's floor plans, framing plans, details
MATERIALS:	As per specifications - framing lumber, 6d, 16d common nails
TOOLS AND EQUIPMENT:	25' steel tape, chalkline, framing square, pencil, cross-cut saw (hand or power), claw hammer
GENERAL INSTRUCTIONS:	Bridging stiffens and supports joists, spanning wide areas. It is recommended that bridging be spaced at intervals not to exceed 8'-0. Therefore, areas being spanned wider than 16'-0 should have two rows of bridging equally spaced across the width of the span.
PROCEDURE AND/OR TASKS	III-B-2(TS), Lay Out And Cut Wood Cross Bridging III-B-2a(TS), Install Wood Cross Bridging III-B-2b(TS), Install Solid Bridging
CHECKING POINTS:	Check bridging location and direction Check cut length: cross bridging; solid bridging Check final installation, all bridging

TASK: Lay Out And Cut Wood Cross Bridging

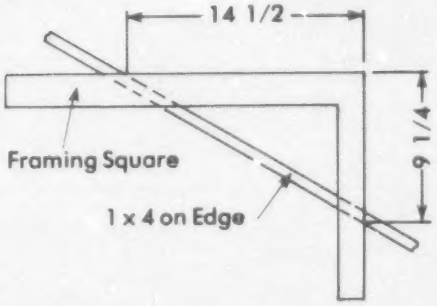
JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: Framing square, pencil, 1 x 3 or 1 x 4 lumber as per specifications

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Select Materials	1. Size as per plans and details 2. Grade as per specifications
2. Position Material	1. On a flat smooth surface 2. Standing on edge
3. Verify Joist Dimensions	1. Actual height of joists Example: 2 x 10 joists actually 9¼" high 2. Actual distance between joists Example: 2 x 10 joists 16" O.C. actually 14½" between joists
4. Position Framing Square	1. Flat on edge of material 2. With 9¼" dimension outside of tongue to bottom edge of material 3. With 14½" dimension outside of blade to top edge of stock
5. Mark Bevel One End	1. Outside of tongue 2. Across top edge of stock
6. Mark point Other End	1. On 14½" dimension outside of blade 2. At top edge of stock
7. Slide Square Along Stock	1. In direction of marked point 2. Until outside of tongue is aligned with marked point 3. Maintain 9¼" and 14½" dimensions on respective edges of material, or . . .
7. (ALTERNATE) Rotate Framing Square	1. 180° horizontally 2. Place 9¼" dimension outside of tongue on marked point at top edge of stock 3. Place 14½" dimension outside of blade to marked line at bottom edge of stock



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STEPS	KEY POINTS
8. Mark Bevel Opposite End	1. Outside of tongue 2. Across top edge of stock
9. Mark Lines To Square	1. Across one face of stock 2. Each end at marked bevels
10. Cut Bridging Pattern	1. Square 2. To lines 3. To bevels
Check Point:	Position bridging between two joists a. With bevel ends flush to sides of joists b. One end to top edge of joist c. Opposite end to bottom edge of adjacent joist Check: Bridging not to extend above or below joists Check: Bevel ends to be flush against sides of joists Note: Use first piece as a pattern to cut other pieces as required

TASK: Install Wood Cross Bridging

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape, chalkline, claw hammer, 1 x 3 or 1 x 4 bridging, 6d common nails

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Establish Bridging Location	1. Measure from appropriate building line 2. Dimension as per floor framing plan 3. At each end of building 4. Snap chalkline across tops of joists 5. Between points measured
2. Start Nails	1. At ends of bridging material 2. Two 6d nails each end 3. Approximately ¼" from end and edges 4. On sides opposite of bevel 5. Slant nails slightly toward end of material
3. Position and Nail First Piece	1. Between two joists 2. One side to chalkline 3. Beveled ends flush to sides of joists 4. Top end flush with top of joist 5. Nail bridge at top of joist only
4. Position and Nail Second Piece	1. In next opening 2. On same side of chalkline 3. With top of bridge to same joist as first 4. Position and nail similar as step #3 above
5. Position and Nail Rest Of Bridging	1. Similar as in step #3 above 2. Continue zigzag pattern a. Tops-to-tops, bottoms-to-bottoms of same joists b. On same side of chalkline 3. Reverse zigzag pattern on opposite side of chalkline to form cross bridging Note: Do not nail bottom of bridging until the joists are ready to be enclosed
Check Point:	Check bridging as it is positioned to insure it does not extend above or below joist lines

TASK: Install Solid Bridging

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape, chalkline, framing square, pencil, cross-cut saw (hand or power), claw hammer

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Verify Joist Dimensions	1. Joist size 2. Distance between joists Example: 2 x 10 joists 16" O.C. = 14½" between
2. Select Material	1. As per plans and details (same as joists) 2. Grade as per specifications (same as joists)
3. Cut Material To Length	1. Square 2. Half of requires pieces to length, 14½" 3. Half of required pieces 1/16" over length, 14 9/16"
4. Establish Bridging Location	1. Dimensions as per floor framing plan a. Measure from appropriate building line(s) b. Each end of building 2. Snap chalkline a. Across tops of joists b. Between points measured
5. Position First Piece (14½"long)	1. Between two joists 2. On edge square a. Square and normal to joists b. One side to chalkline c. Top flush with top of joists
6. Nail First Piece	1. While holding in place 2. Use (3) 16d nails each end 3. Face nail thru joists 4. Centered vertically with bridging
7. Position and Nail Other 14½" Long Pieces	1. In every other joist spacing 2. On same side of chalkline 3. Similar as first piece, steps #5 and #6
8. Position and Nail All Pieces 14 9/16" Long	1. On opposite side of chalkline 2. In alternate/open joist spacing 3. Similar as first piece, steps #5 and #6

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

III-C-1(S)

TASK:	Install Wood Board Subfloors
AIM:	The student(s) will be able to properly install plain wood board subfloors follwoing acceptable building practices and procedures.
TOOLS AND EQUIPMENT:	25' steel tape, chalkline, combination square, cross-cut saw (hand or portable power), claw hammer
MATERIALS:	Shiplap, tongue and groove, or common boards as called for in plans and specifications, 8d common nails as required
TEACHING AIDS:	Plans and specifications
REFERENCES:	Modern Carpentry, Unit 7, Floor Framing
PREREQUISITE EXPERIENCE OF THE LEARNER:	The student must have successfully completed all previous related information lessons in Major Block III. The student must further continue to show a sincere interest in learning the building trades.
CHECKING STANDARDS:	1. Check material selection and layout 2. Check joints, nailing patterns 3. Check completed subfloor installation

I. PREPARATION (OF THE LEARNER - MOTIVATION)

In wood frame construction, sound subflooring is absolutely a "must". Although its primary purpose is to provide a solid base on which to install the finished floor, it serves several other functions. Nailed directly to the joists and headers, it lends bracing strength to the building; it provides a solid base making floor sag and squeaks unlikely; it acts as a barrier (insulator) to cold and dampness; and it serves as a safe working platform during the remainder of construction.

Wood boards used as a subfloor may be applied diagonally or at right angles to the joists. Many builders prefer diagonal installation of subfloor boards as it provides somewhat better bracing and stiffness to the building and permits the finish strip floor to be laid in either direction - parallel or perpendicular with joists.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. Install Wood Board Subfloor Straight	1. Study plans, specifications 2. Determine direction of floor joists 3. Determine type, size, grade of subfloor material
A. Select Material	1. As per plans and specifications 2. Pick and choose to: a. Reduce waste b. Insure boards span three or more josts

c. Stagger joints over different joists
d. To cull excessive faulty boards

B. Position First Row

1. Start at one side and one end
   a. Work across (at right angles) with floor joists
   b. End may overhang outside of header joist
   c. Opposite end square and centered over a floor joist
   d. Side flush with outside of header

Note: If tongue and groove center match is used place groove side flush with outside of header

2. Align and temporarily nail in place
3. Cut second board to:
   a. Butt against end of first board
   b. End square and centered over a joist
4. Align and temporarily nail in place

Note: Continue in the same manner until the other end of the building is reached. The last piece may overhand the opposite end somewhat

C. Face Nail First Row

1. Use 8d common nails
   a. (2) each joist for boards 6" wide or less
   b. (3) each joist for boards over 6" wide
2. Centered over each joist or . . .
3. 3/8" from end of boards at joints

D. Lay Subsequent Rows of Straight Subfloor

1. In a similar manner
2. One row at-a-time
3. Stagger joints on different joists

Note: Omit temporary nailing on subsequent rows unless necessary to pull warped boards in lines

4. Repeat procedure until subfloor has been completed

E. Trim Overhand

1. Snap chalklines
   a. On top of subfloor
   b. Along building lines (outsides of headers)
2. Cut overhang to lines
   a. Set circular portable power saw to cut 3/4" depth
   b. Cut to lines

2. Install Wood Board Subfloor Diagonally

Note: Reverse direction of diagonal flooring each floor on multi-story structures.

A. Locate Starting Line

1. On top of floor frame
2. Measure from building corner
   a. 10'-0 along header joist
   b. 10'-0 along header
3. Mark points along outside edges

4. Snap chalkine
   a. Between points measured
   b. Diagonally across tops of joists

B. Select Material

1. Similar as in step #1 A this lesson
2. Pick and choose to
   a. Reduce waste
   b. Insure boards span three joists
   c. Allow ends to be cut 45° for joints over joists
   d. To stagger joints over different joists

C. Install First Row

1. Cut one end at 45° angle
2. Position board to chalkline
   a. Beveled end centered over joist
   b. Opposite end overhanging edge of floor
   c. Work back toward corner
3. Align and temporarily nail in place
4. Cut second board on 45° bevel each end to:
   a. Butt against end of first board
   b. Center opposite end over a joist
5. Align and temporarily nail in place

Note: Continue in the same manner until the first row of diagonal flooring is positioned

6. Face nail first row
   a. Use 8d common nails
   b. Centered over each joist or . . .
   c. 3/8" from end of boards at joints
   d. Use (2) nails each joist for board widths 6" or less
   e. Use (3) nails each joist for board dths over 6"

D. Lay Subsequent Rows of Diagonal Subfloor

1. In a similar manner
2. One row-at-a-time
3. Work toward corner first
4. Stagger joints on different joists

Note: Omit temporary nailing unless necessary to pull warped boards in line

5. Repeat procedure until subfloor has been completed

E. Trim Overhang

1. Snap chalkline
   a. On top of subfloor
   b. Along building lines (outside edges of headers)
2. Cut overhang
   a. Set circular portable power saw to cut 3/4" deep
   b. Cut to chalklines

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

Instructor: Demonstrate skills
Pass out job and task sheets

Students: Practice tasks under close supervision of instructor

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

Performance Test!

Students install wood board subfloor diagonally according to builder's plans and specifications

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

Sound subflooring is absolutely a "must" in wood floor framing. Wood board subfloors laid diagonally provide somewhat better bracing and stiffness to the building.

Measure 10'-0 from the building corner along the tops of the header and header joist and pop a chalkline diagonally across the floor joists to locate the first board.

Choose the first board to span this diagonal distance and position it to the line working back towards the corner. Face nail centered over each joist using 8d nails - (2) nails on 6" widths and under; (3) nails on boards over 6" width.

Pick and choose material to reduce waste, insure the boards span three or more joists, to stagger joints over different joists, and to trim ends 45° for joints.

Mark, cut, and install boards one-at-a-time until subfloor is complete.

SUGGESTED READING FOR STUDENTS:

Modern Carpentry, Unit 7

THE NEXT LESSON IS: III-C-2(S), Install Plywood Subfloor

JOB SHEET
IN
FLOOR FRAMING

III-C-1(J)

JOB:	Install Wood Board Subfloors
DRAWINGS:	Builder's floor plans, framing plans, and details
MATERIALS:	Shiplap, tongue and groove, or common boards as called for in builder's specifications, 8d common nails as required
TOOLS AND EQUIPMENT:	25' steel tape, chalkline, combination square, cross-cut saw (hand or portable power circular), claw hammer
GENERAL INSTRUCTIONS:	Select several straight flooring boards with which to start. Getting the proper start and alignment is very important. Cut, fit, and align the first row of flooring very meticulously, and subsequent rows of flooring will install much easier. In humid climates where the subfloor is apt to become wet during the building process, it si a good idea to have a small, uniform space between rows of flooring to allow for the swelling of wood and drainage for water. Many carpenters use a 4d or 6d nail between boards to maintain this space. Often carpenters work in teams laying subfloors - one laying out and cutting boards to length; one positioning and nailing the subfloor in place.
PROCEDURE AND/OR TASKS:	III-C-1(TS), Install Wood Board Subfloor Square With Joists III-C-1a(TS), Install Wood Board Subfloor Diagonally To Floor Joists
CHECKING STANDARDS:	1. Material selection 2. Joints properly staggered 3. Adequate nails employed 4. Overall subfloor installation

TASK SHEET III-C-1(TS)

TASK: Install Wood Board Subfloor Square With Joists

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: Square (combination or try), cross-cut saw(hand or circular portable power), hammer (claw), shiplap, tongue and groove, or common boards as per builder's specifications, 8d common nails as required

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Study Plans; Specifications	1. Determine direction of floor joists, subfloor 2. Determine type, size, grade of subfloor material
2. Select Material	1. Several straight boards to start 2. Pick and choose to: a. Cull excessive faulty boards b. Stagger joints over different joists c. Insure board spans three joists d. Reduce waste
3. Position First Row	1. Start at one side and one end 2. Work across (at right angles with) floor joists with: a. Side of board flush with side of header Note: If tongue and groove centermatch is used, place grooved edge to outside of header b. End of board may overhang outside of frame c. Opposite end square and centered over a joist 3. Align and temporarily nail in place 4. Cut second board to: a. Butt against end of first board b. End square and centered over a joist 5. Align and temporarily nail in place Note: Continue in same manner until the opposite end of the building is reached. The last piece may overhang the opposite end
4. Face Nail First Row	1. Use 8d common nails a. Two nails centered over each joist for boards 6" wide or less b. Three nails centered over each joist for boards over 5" wide 2. 3/8" from end of boards at joists - stagger slightly

STEPS	KEY POINTS
5. Lay Subsequent Rows	1. In a similar manner one row-at-a-time 2. Stagger joints on different joists 3. Omit temporary nailing unless necessary to pull warped board in line 4. Repeat procedure until subfloor is complete
6. Trim Overhang	1. Snap chalklines a. On top of subfloor b. Along building lines (outside of headers) 2. Cut overhang a. Set circular portable power saw to cut 3/4" deep b. Cut to lines

TASK SHEET III-C-1a(TS)

TASK: Install Wood Board Subfloor Diagonally

JOB: Floor Framing

TRADE: Building Trades

TOOLS AND MATERIALS: 25' steel tape, chalkline, combination square or T-bevel, shiplap, tongue and groove, or common boards as per builder's specifications. 8d common nails as required

TASK BREAKDOWN:

STEPS	KEY POINTS
1. Study Plans; Specifications	1. Become familiar with floor framing details; dimensions 2. Determine type, size, grade of subfloor material
2. Locate Starting Line	1. Measure from building corner 2. Along top outside edge of header; header joist 3. 10'-0 each direction 4. Mark points measured 5. Snap chalkline a. Between points measured b. Diagonally across tops of joists
3. Select Material	1. Similar as in task III-C-1(TS) 2. Pick and choose to: a. Insure boards span three joists b. Allow ends to be cut on 45° bevel at joints c. To stagger joints over joists d. Reduce waste e. Cull excessive faulty boards
4. Install First Row	1. Cut one end of first board on a 45° bevel 2. Position first board a. To chalkline b. With body toward corner c. With beveled end centered over a joist d. Opposite may overhang outside of frame 3. Align and face nail in place a. Use 8d common nails b. Two nails centered over each joist boards 6" or less in width c. Three nails centered over each joist for boards over 6" in width d. Nail 3/8" from end of boards at joints

STEPS	KEY POINTS
	4. Cut second board on 45° bevel each end to: a. Butt against end of first board b. Align with chalkline first board c. End centered on a joist 5. Align and nail in place similar as first board Note: Continue in the same manner until the first row is complete. Allow last piece to overhang floor frame
5. Install Subsequent Rows	1. In a similar manner 2. One row-at-a-time 3. Work toward corner first 4. Pick and choose flooring material 5. Stagger joints on different joists Note: Continue in the same manner until the subfloor is laid
6. Trim Overhand	1. Snap chalkline a. On top of subfloor b. Along building lines (outside edges of headers) 2. Cut overhang a. Set circular portable power saw blade to cut 3/4" deep b. Cut to chalkline

INSTRUCTOR'S PLAN
MANIPULATIVE LESSON

III-C-2(S)

TASK:	Install Plywood/Fiberboard Subfloor
AIM:	The student(s) will be able to properly install a plywood subfloor following acceptable building practices and procedures.
TOOLS AND EQUIPMENT:	Steel tape, framing square, circular portable power saw, claw hammer, chalkline, pencil
MATERIALS:	5/8" plywood and/or fiberboard panels as per builder's plans and specifications; 8d common nails as required
TEACHING AIDS:	Builder's plans and specifications, job and task sheets
REFERENCES:	Wagner, Willis H., Modern Carpentry
PREREQUISITE EXPERIENCE OF THE LEARNER:	The student must have successfully completed Related Information lessons in Major Block III; all safety lessons to date; and continue to display sincere interest in learning the building trades.
CHECKING STANDARDS	1. Position and alignment of panels 2. Maintain sufficient spacing between panels 3. Panel joints staggered and centered over joists 4. Nailing pattern adequate

I. PREPARATION (OF THE LEARNER - MOTIVATION)

In modern construction, plywood and/or fiberboard is gaining popular use as subflooring. Although ½" plywood over joists spaced 16" O.C. meets minimum F.H.A. requirements, most builders prefer 5/8" or even 3/4" plywood for single subfloor. It provides a smooth, even base; can be installed rapidly; usually insures squeak-free floors; plus acts to stiffen and strengthen the building horizontally. Plywood is generally laid with lengths across the joists.

However, plywood is often used as a combined subfloor with boards to provide underlay for such finish floors as linoleum, vinyl tiles, and carpet. In such cases, the plywood may be laid either at right angle or parallel with the floor joists and does not have to be as thick.

II. PRESENTATION (OF THE SKILLS)

STEPS	KEY POINTS (THINGS TO REMEMBER TO DO OR SAY)
1. Study Plans; Specifications	1. To become familiar with floor framing plans, details, dimensions 2. To determine size (thickness) and type of subfloor panels 3. To determine direction of placement of subfloor panels 4. To estimate required panels for subfloor
2. Set 1st Panel	1. Start at one outside corner 2. Length at right angles with floor joists 3. End and side flush to outside of floor frame

4. Face nail to joists and headers
   a. Use 8d common nails
   b. Drive just enough nails to hold the panel in place

3. Set 2nd Panel
   1. Position at end of 1st panel
   2. Align with 1st panel; edge of floor frame
   3. Allow approximately 1/32" between ends of panels
   4. Be sure joint is centered over joist
   5. Temporarily nail in place as previous panel

   Note: Continue in this manner until 1st row of panels are installed. Measure and cut the last panel to length before installing

4. Begin 2nd Row
   1. Start at the same end of the building
   2. Cut a panel in half
   3. Position half panel
      a. Flush with end of floor frame
      b. Opposite end centered over 4th joist
      c. Grain at right angles with joists
      d. Edge adjacent to edge, 1st row
      e. Allow approximately 1/32" space between panels
   4. Temporarily nail in place as previous panels

   Note: Continue to lay and nail panels in this and subsequent rows of floor panels in similar manner. Maintain 1/32" spacing between panels. Stagger joints

5. Nail Subfloor Panels
   1. Use 8d common nails
   2. Face nail
   3. Space 6" along edges and ends
   4. Stagger nails slightly at joints
   5. Space 10" along intermediate members

III. APPLICATION (PRACTICE BY LEARNER UNDER CLOSE SUPERVISION)

Instructor: Pass out job and/or task sheets

Students: Practice tasks under close supervision of instructor

IV. VERIFICATION AND/OR EVALUATION (CHECK ON STUDENT'S ABILITY)

Performance Test!

Students lay wood panel subfloor according to builder's plans and specifications

V. SUMMARY (TELL THE STEPS ON PROCEDURE AS TO WHAT, HOW, AND WHY. REVIEW CHECKING STANDARDS. THIS SUMMARY MAY BE GIVEN AT ANY PLACE IN THE LESSON THE TEACHER FEELS WILL BE PROFITABLE TO THE STUDENTS.)

Plywood - wood panel subfloors are generally at right angles with floor joists. Study the plans and specifications to become familiar with floor framing details and determine the direction of floor joists to plan your flooring procedure.

Start at an outside corner, placing the first panel flush with the edge and the end of the floor frame so that the grain of the wood (panel length) is at right angles with the floor joists and the other end is centeredover a joist. Nail just enough to hold the panel in place using 8d commons. Place the next full panel against the end of the first panel; align leaving a 1/32" gap between panels and nail as first panel. Continue in this manner until the first row of panels are laid. Note: The last panel may have to be measured and cut to fit the building length.

Start the second row from the same end of the building. Cut a panel in half, lay the end flush with the outside of the building floor frame and alongside the first row. Nail the half panel to the floor joists similar as the first panel. Continue to lay and nail panels in the second row until complete.

Start the third row with a full panel. This will stagger the joints and provide a stronger floor. Continue laying panels, staggering joints, maintaining 1/32" gap, and driving just enough nails to hold each panel in position until all panels are laid.

Complete the nailing as required. Use 8d common nails spaced 6' around panel perimeter and spaced 10" over intermediate members (joists).

SUGGESTED READING FOR STUDENTS:

Modern Carpentry, Unit 7
Framing, Sheathing, And Insulation, Unit 9

THE NEXT LESSON IS: IV-A-1(S), Install Sole Plates

JOB SHEET
IN
FLOOR FRAMING

III-C-2(J)

JOB: Install Wood Panel Subfloor

DRAWINGS: Builder's plans and specifications

MATERIALS: 5/8" plywood panels, 4' x 8' sheets as required 8d common nails as required

TOOLS AND EQUIPMENT: Rule or steel tape, chalkline, framing square, cross-cut saw (hand or circular portable power), claw hammer

GENERAL INSTRUCTIONS: Study plans and specifications. Become familiar with floor frame details and dimensions; direction of floor joists.

Start the first row at an outside corner and place the panel lengths across the floor joists and flush with the outside of the floor frame. End joints should be centered over a joist, allowing 1/32" gap between panels. Face nail just enough to hold panels in place.

Start the second row with a half panel to stagger the end joints. Continue to lay panels maintaining 1/32" gap and staggering joints until subfloor is complete. Complete nailing as required using 8d common nails spaced 6" along edges and 10" along intermediate members.

PROCEDURES AND/OR TASKS:

1. Study plans, specifications - determine direction of floor joists.
2. Lay 1st row - start at outside building; lay panels across joists; align with outside edge of floor frame.

CHECKING POINTS: Panel ends centered over a joist; 1/32" gap maintained between panels.

3. Face nail panels just enough to hold in place.
4. Lay 2nd row - start with a half panel to stagger joints; follow similar procedure as first row.

CHECKING POINTS: (Same as above) plus maintain alignment, 1/32" gap with 1st row. Note: Continue to lay panels maintaining 1/32" gap and staggering joints until subfloor is complete.

5. Complete nailing as required - use 8d commons; space 6" along edges, 10" along intermediate members - face nail.